Appendix I.

REPORT

ON

Waste Water Salvage Project

TO

Board of Directors
Santa Clara Valley Water Conservation District
San Jose, California

FRED H. TIBBETTS,
Civil Engineer
San Francisco

with an introduction by
LEROY ANDERSON, *President*,

the financing plan by
HERBERT C. JONES, *Attorney*

and a review by
HARRY L. HAEHL, *Consulting Eng.*
San Francisco

October 2, 1931

Vol. 3: 20-529

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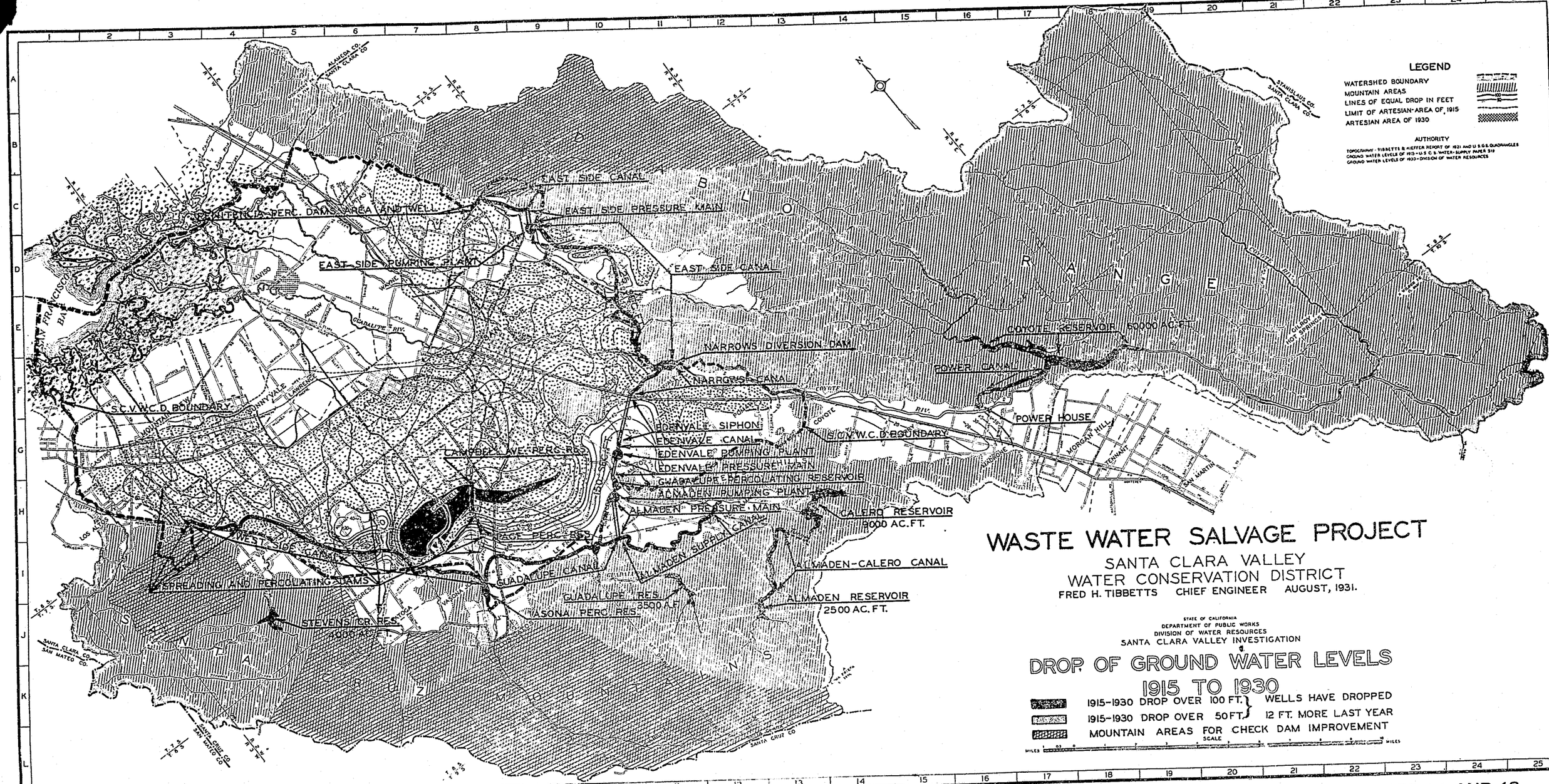
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PLATES 1 AND 18

Santa Clara Valley Water Conservation District

SAN JOSE, CALIFORNIA

OFFICERS

President
Leroy Anderson
Secretary
R. P. Van Orden
Attorneys
Jones & Douglas
Chief Engineer
Fred H. Tibbetts

DIRECTORS

S. D. Farrington, Division I
Leroy Anderson, Division II
R. P. Van Orden, Division III
J. Fred Holthouse, Division IV
Ralph F. Simons, Division V
John A. Fair, Division VI
C. D. Cavallaro, Division VII

A Brief History of the District

By LEROY ANDERSON

The present water conservation district may be said to have had its beginning in a conference called by farm organization committees in February, 1926. Delegates to the number of two dozen or more met on the 27th of that month in response to the call issued by a committee made up of the legislative committee of Pomona Grange and the water conservation committee of the County Farmers Union. A quotation from the call shows how that group then felt about the water situation.

> "It seems appropriate that the organized farmers should make an effort to solve our serious water problem, and we hope that each Grange and Farmers Union will join heartily in the idea. As soon as possible elect or appoint two of your best members to represent you at the proposed conference. It is not expected that ways and means will be discussed at this conference, but what, in the light of our experience, is the next thing to do to lead toward practical water conservation."

The "conference" devoted the next few months to a study of various state laws governing irrigation and conservation districts in the hope of finding an act that would fit conditions in Santa Clara Valley. Not being able to hit upon one, the conference decided to do some practical water conservation.

In the fall of 1926 the committee began spreading water on Guadalupe creek by means of sack dams. Finding that land must be leased or purchased, it became necessary to have some legal body, and the Valley Water Conservation Association was incorporated December 1, 1926. The incorporating directors were:—Nelson Barton, Karl E. Bracher, John A. Fair, Lloyd Gardner, S. N. Hedegard, Edwin Howes, Warren E. Hyde, W. K. Roberts, R. P. Van Orden, Max Watson, J. E. Wiesendanger, Leroy Anderson.

Contributions were sought to defray expenses of water saving,—from farmers on the basis of fifty cents per acre and from others as much as could be secured. These ranged from five to one thousand dollars and in

the course of two years or more a total of $10,000 had been contributed by individuals and corporations who believed in saving water.

The Association continued spreading operations on the Guadalupe but changed the type of spreading dam from sacks to one of steel and rock. Portions of two old irrigation systems on Los Gatos creek were purchased to be used for percolation, a concrete diversion wier at the head of this system was built and altogether some sixty per cent of money contributed was invested in permanent works.

Passing the hat could not solve the increasingly serious water situation of the Valley,—a fact the directors of the Water Association realized more than those who were not in close touch with conditions. Therefore attention was turned again to the idea of forming a district under some statute that might be found suitable. The legislature of 1927 had passed a new water conservation act which had for its principle of saving water, the storing under ground and putting it there by spreading and percolation. Since the charter of the Association did not permit of spending its money for other purposes than the actual saving of water, another body was organized to study a district plan.

A mass meeting held in San Jose Chamber of Commerce in April, 1928, authorized the appointment of a committee of fifteen whose duty would be to study the water conservation act of 1927 to see if it could apply to our Valley and if not, devise some method which would apply. During the following summer a series of meetings was held over the Valley to determine sentiment, and the almost unanimous opinion was that a district should be formed provided the entire Valley, urban and rural, be included.

The water conservation act of 1927 levies assessment on both land and improvements. Such a levy would work hardship on a city like San Jose where improvements are of higher value than the land, while in rural sections improvements are about half the value of the land. Hence it did not seem wise to ask our citizens to organize under the 1927 act and the committee decided to introduce a new act in the 1929 legislature having assessments levied on land alone. The act was drawn and introduced by Senator Herbert C. Jones and became a law at that session.

As soon as the law became effective on August 15, 1929, the committee circulated the requisite petitions and in a few days secured three times the necessary number of signatures. The Board of Supervisors approved the boundaries suggested and ordered an election which was held on November 5, 1929. Out of 5993 votes cast 5389 were for the district and 604 against.

For convenience in electing directors the district was divided into seven divisions, each choosing a director whose term is four years. Regular elections will be held the first Tuesday in February in odd numbered years: divisions I, III, V and VII holding election in 1931, and the other three divisions in 1933. The original seven directors were:—S. D. Farrington, Division I; Leroy Anderson, Division II; R. P. Van Orden, Division III; J. Fred Holthouse, Division IV; Edgar A. Jackson, Division V; John A. Fair, division VI; C. D. Cavallaro, Division VII.

The act provides that regular county officers function for the district in their capacity as assessor, tax collector, auditor and treasurer. The district's assessment of land values is taken from the county rolls. All warrants drawn by the district are paid by the county treasurer after approval by the county auditor.

The first assessment under the new district was levied by the Board of Supervisors in the fall of 1930 upon an assessed land value of $38,591,615. The receipts for 1930-31 were $56,712.03. The assessed land value for the year 1931-32 is $39,544,845.

It soon becoming evident that the 15 per cent assessment on each one hundred dollars of land value could not furnish sufficient money to save for Valley use the water falling upon our mountain slopes, the directors of the district proposed that the organization act be so amended as to enlarge the district's powers. Accordingly four amendments were drawn to (1) permit the district to vote bonds, (2) permit additional territory to join the district, (3) permit the district to take sewage or other waste water from cities, treat it and sell the effluent for any useful purpose, and (4) permit the district to vote special assessments.

Whether the district votes special assessments or bonds, the levy is on land values only and not on improvements.

The four amendments were written and introduced in the 1931 legislature by Senator Herbert C. Jones and signed by the Governor June 17. Immediately thereafter the directors engaged Mr. Fred H. Tibbetts, consulting engineer of wide experience, of San Francisco, as Chief Engineer, and instructed him to prepare a plan for salvaging the Valley's water which would otherwise waste to the ocean.

Mr. Tibbetts' informal report, presented on August 17, was so acceptable to the Board that he was instructed to present it in form for printing. The latter presentation was made at a regular quarterly meeting of the Board on September 1. The Board adopted the report and ordered it printed as required by law in anticipation of a bond election.

Mr. Tibbetts' report follows and is heartily commended to all citizens of Santa Clara Valley. The condition of the Valley as to its water, foreseen years ago, is even worse now than was then anticipated. Mr. Tibbetts' plan offers a feasible and economical means of saving us from a worse situation.

The Board of Directors feel that the problem is too vital to be longer withheld from the voters of the District. We believe that our situation has become so critical that our people are entitled to say for themselves whether they do not believe that the time has come when without further delay we should take steps to save the floods that mean the salvation of our Valley.

How To Finance The Plan

By HERBERT C. JONES

The Santa Clara Valley is today facing a crisis in its history. Large portions are doomed to become a desert. We have been exhausting our water capital. In some localities it already costs more to pump water than the returns from the crops justify. The scanty underground reserve is today disappearing rapidly.

Present Waste of Water.

The report of Mr. Fred H. Tibbetts is by one of the most experienced and competent engineers in the State of California. It shows that every year we permit a tremendous amount of flood waters to go to waste. If we saved it instead, it would be sufficient to meet the present and prospective needs of the Valley, and at the same time restore the vanishing water table. This waste has gone on steadily; even in the present cycle of dry years, twelve out of these last fourteen years have shown a vast amount of water flowing unused into the Bay. This waste is 62% of the available run-off. If we save even one-third of this 62% waste, that will be sufficient to hold the water table at its present level; any amount that we save beyond that will cause the table to rise gradually.

Present Expense.

The annual power bill for pumping the present diminishing water supply out of the ground is now $665,000.00 larger than the power bill fifteen years ago on the same installed horsepower. It takes fifteen times as much power as it did then to lift our water. What will it take next year, and the next, and the next? Nine years of saving of this power bill would pay for the whole project. Likewise, in the past fifteen years we have spent over $6,000,000 for deepening wells and enlarging pumping plants, and all this time the water table has fallen steadily, and 62% of the flood waters have wasted into the Bay. This cost for deepening our wells has solved nothing, and yet it has likewise cost as much as the total amount of this new project. The only solution is to refill the water table and save the flood waters by this plan, for this is a permanent solution.

New Plan.

The report of Mr. Tibbetts was subjected to a careful and independent analysis by Mr. Harry Haehl, a second engineer employed by the District, with nearly one-third of a century experience in water problems. Mr. Haehl, after an intensive study on the ground, and after checking Mr. Tibbetts' estimates, has pronounced the plan as the only feasible plan for Santa Clara Valley.

The people of the Santa Clara Valley Water Conservation District now have the remedy in their hands. It is outlined in the Tibbetts report, and consists of a system of dams and reservoirs where floods are impounded during the rainy season and released throughout the year into stream beds and percolating canals designed to sink the water into the gravels under all portions of the Valley. This is the biggest and finest project Santa Clara Valley has ever undertaken. At the last session of the Legis-

lature a law was passed which permits the voters of the District to vote bonds to pay for the necessary dams, reservoirs and percolating canals. The estimates of the two engineers for constructing the necessary works correspond very closely, with less difference in their figures than the usual variation between contractors in bidding on construction. However, it is the intention of the Board to expend only what is actually necessary, so that if the works can be constructed for any lesser amount than the estimates the saving will be effected for the taxpayers of the District.

To authorize the bonds requires the vote of two-thirds of the electors of the District. Those who are qualified to vote are all electors entitled to vote at the 1930 elections and all who have registered in 1931 prior to 40 days of the proposed bond election.

Tax on Land Only.

These bonds are to be repaid by a tax levied against the assessed valuation of the LANDS within the District, but not against the improvements. Thus, if a voter has a home upon which the assessed value of the land is $500.00 and the assessed valuation of the house is $2000.00, this tax is computed only on the $500.00 valuation of the land and not on the entire valuation of $2500.00. The assessed valuation of trees, as well as buildings, is exempt from this tax.

As the great majority of residence lots are assessed for approximately $400, the largest annual tax for the owner of such a lot would not exceed $5.76, while for the first five years it would average only about half that amount annually.

In order to gain a more complete picture of the financial side of the proposed project, the following figures may be given:

Assessed valuation of land in the District	$39,544,845.00
(This is the basis for computing the Tax)	
Proposed bond issue	6,000,000.00
Annual payment of principal (20 installments)	300,000.00
Interest first year when principal payments begin, at 4½%	270,000.00
Annual reduction in interest	13,500.00

It should be borne in mind that the foregoing rates are computed only on the assessed valuation of lands, and that as lands constitute less than one-half of the total assessment rolls ($84,069,815.00), the foregoing rates would be reduced by more than one-half if computed also against assessed valuation of improvements and personal property, as in the case of city and county taxes.

The total payments for bonds for the first and the 20th years (after payments of principal begin) will therefore be as follows:

5TH YEAR (1937)

Principal	$300,000
Interest	270,000
Total	$570,000

25TH YEAR (1956)

Principal	$300,000
Interest	13,500
Total	$313,500

Deferred Payment.

The period for which the bonds are to run is 25 years. The law provides, however, that the Board of Directors may defer the payment of principal for five years, in which case the principal is repaid in 20 years. It is the plan of the Board to defer the first payment on the principal for five years. This period should carry us through the present depression and bring us into a time when business conditions are again prosperous. Also, it would defer the payment of principal until the benefits from the construction begin to make themselves felt, with a rising water table and decreasing pumping costs.

Taxes Kept Down.

In addition to deferring the payment of principal during the present slump, the tax burden will also be kept down in the beginning because the Board will only have to sell bonds as the work progresses. In all probability the total amount of the bonds will not be required until the expiration of two or three years. During the first year there will be no payment on principal and probably interest on less than half the amount of the bond issue. This should make the tax quite light until normal business conditions are restored and the benefits from construction noticeable.

Average Annual Payment.

Mr. Tibbetts estimates that during the first year only one-half of the total bond issue can be utilized, and that it will be two years before all of the bonds are required to be sold. With the interest charge thus being low at first, and coming on progressively, the estimated tax rates for the entire 25 years will be as follows:

ESTIMATED TAXES FOR WATER SALVAGE PROJECT (ARE PAID ON ASSESSED LAND VALUE ONLY)

	Tax Rate for Bond Interest and Retirement of Principal Per $100.	Total Tax for Typical City Lot. Land Assessed $250 (Improvements Assessed $2,000, Not Taxable.)	Total Tax for Typical 20 Acre Orchard. Land Assessed $4,000. (Trees and Improvements Assessed $2,000, Not Taxable.)
1st Year Int. Only	$ 0.17	$ 0.43	$ 6.80
2nd Year " "	0.52	1.30	20.80
3rd Year " "	0.68	1.70	27.20
4th Year " "	0.68	1.70	27.20
Average-5th to 25th years-when principal retirement occurs.	1.12	2.80	44.80

Rate per $100 assessed land value for first year when payment on principal begins, $1.44. Rate decreases each year until last, or 25th year, to $0.79. Average rate, $1.12.

After the 3rd year add 10 cents (estimated) to the above rate for operation and maintenance of the completed project.

If this tax rate were levied on the total valuation, like our other tax bills, instead of merely the land, the above tax rate would be only 46% as much—less than half.

Additional power costs now being paid because of fall in wells in the last 15 years are equivalent to a rate of $1.66, and this is increasing faster every year as water goes deeper.

Low Construction Costs

The present time has various advantages in financing the proposed undertaking. The rate of interest to be paid on the bonds is lower than for years. Likewise the cost of materials and construction is lower than it has been at any time in the last decade. Furthermore, there has been such a marked improvement in machinery for excavating and moving earth that the cost of the dams and the canals will be much less than a few years ago.

Increased Employment.

The building of these works at this time is in accordance with the policy urged by the Federal and State Governments for the erection of permanent capital improvements to relieve unemployment. It will be the means of putting to work many hundreds of our Santa Clara Valley citizens. This is not a proposal to spend money outside of our community; in fact, practically all the money will be retained right here in the Valley. The money spent for labor, and for materials and supplies, should largely go to our own community. It will be putting into circulation a large amount of money for which greater returns can be obtained than at any time in the last decade. The wages paid to the workmen will be reflected in increased business for our merchants.

A Permanent Saving

This whole plan has very properly been described as one to save the money which would otherwise be required to further deepen our wells; it is designed to cut down our power bills. The saving can be illustrated by the case of one land owner who recently lowered his well at a cost of $5000.00—imposing a charge for interest of $350.00 a year perpetually. His maximum tax under this bond issue for the year when the greatest amount was being paid off by the District, would be but $108.00.

The project is under the management of a board of seven directors, all of whom are long-time residents of the Valley, elected by the voters of the several respective divisions of the District.

Desert or Water District?

The results will be disastrous for our Valley if this water conservation plan is further delayed. In some parts of the San Joaquin Valley orchards have died for lack of water and gone back to desert. The same possibility confronts us. For years some solution has been demanded. The lowering of our water table is not a solution. This plan presented by Mr. Tibbetts, and approved by Mr. Haehl, is the only practical one. We must no longer waste our winter floods.

The Metropolitan Water District in Southern California last week bonded themselves for $220,000,000. Their tax will be substantially the same as the proposed tax in our District. We hear much of the energy and civic spirit of Southern California. Shall we be less constructive, less far-sighted, less self-reliant, less courageous than our brothers of the South?

TELEPHONE DAVENPORT 113

FRED H. TIBBETTS
RALPH G. WADSWORTH
HAROLD I. WOOD

FRED H. TIBBETTS
CIVIL ENGINEER
ALASKA COMMERCIAL BUILDING
SAN FRANCISCO, CALIF.

SUBJECT: SANTA CLARA VALLEY WATER CONSERVATION DISTRICT
REPORT ON WASTE WATER SALVAGE PROJECT

Letter of Transmittal

September 1, 1931.

Board of Directors,
Santa Clara Valley Water Conservation District,
95 Auzerais Bldg., San Jose, California.

Gentlemen:

Pursuant to your request and the resolution of your Board, this report has been prepared, and is hereby presented to you, showing the works to be constructed and the property to be acquired convenient or necessary to serve and fulfill the purposes for which the District exists.

The State Division of Water Resources after two years investigation estimates that the ground water supply of the Santa Clara Valley has been depleted during the last 16 years at the average rate of 44,000 acre feet per year and that the ground water has dropped during this period, an average of 4.8 ft. per year. In 1921 Tibbetts and Kieffer estimated the overdraft as 40,000 acre feet per year and predicted a probable drop in the water plane of 4 to 5 ft. per year. This prediction having been accurately confirmed, it can now be predicted with the utmost confidence that unless measures are taken to salvage the large average annual waste of water from the Santa Clara Valley, nothing can prevent the final destruction, from failure of water supply, of large sections of the valley.

Santa Clara Valley is fortunate to have located beneath the valley floor an enormous underground gravel water reservoir vacated by the drop in the water plane in recent years, of about one million acre feet capacity supplying the irrigation wells of the valley. The source of supply of this underground reservoir is percolation from the valley's stream beds supplied by runoff from the surrounding watersheds. The average annual runoff is 202,535 acre ft. The average amount which the stream beds absorb under natural conditions and transfer to the underground gravel reservoirs is 76,485 acre ft. per year or 38% of the total. The average wastage is 126,050 acre ft. per year or 62% of the total. This waste is sufficient to cover the entire district annually to a depth of about 11½ inches. As much as possible of this waste must be intercepted and put to beneficial use.

The principal wastage of water occurs during infrequent but heavy floods of short duration. Surface reservoirs must be constructed, where economically feasible, to detain the heavy flood flows until they can be transferred through canals of feasible capacity into the porous valley marginal creek bed areas which will in turn transfer them to the underground gravel storage reservoir. Five reservoirs are recommended on the Coyote,

Almaden, Guadalupe and Stevens Creeks. These four streams have 59% of the total watershed area and yield 58.8% of the total runoff. The total aggregate capacity of the storage reservoirs will be 79,000 acre ft., 60,000 of which will be on the Coyote, which has 44% of the total watershed area and 39.6% of the total runoff. These reservoirs will be used to transfer flood waters to underground storage as rapidly as possible, and thus used, they may be partially filled and emptied repeatedly each season. They should salvage 46,310 acre ft. or 37% of the present average annual waste. This should be more than sufficient to equalize the existing overdraft during the current dry cycle as estimated by the Division of Water Resources. The total estimated cost of the detention reservoir development is $3,607,200, an average of $45.70 per acre ft. of storage capacity and $78.00 per acre ft. of additional salvaged water per annum.

The region of most abundant natural water supply, the Coyote River, is some twenty miles from the region of greatest water depletion along the West Side of the Valley. The excess flood water of the Coyote must be detained in surface storage until it can be transferred, by appropriate works, to underground storage, particularly toward the western and northwestern margin of the Valley. In order that the prior demands of the Coyote Valley may first be satisfied, it is proposed to allow Coyote reservoir releases to flow in the natural stream bed of the Coyote for twelve miles to Edenvale. This twelve miles includes all of the porous channel bottom of the Coyote and this transfer insures full well replenishment for the Coyote Valley.

In the operation of any of the surface reservoirs it is not intended to intercept any natural stream flow at any time which is being put to beneficial use either by pumping from the streams or by gravity diversions, but only to intercept and pass into gravel storage as much water as possible which would otherwise waste into the Bay.

Distributing channels from the Edenvale Narrows on the Coyote are projected along both margins of the Valley. The main canal will extend 25 miles northwesterly to the margin of the District at Permanente Creek. It will cross at grade, the percolating reservoirs on the Guadalupe and Los Gatos Creeks and can transfer excess flood waters from these streams also, toward the northwest. Three pumping plants will be required, the largest of which will be at the crossing of the Guadalupe. Sufficient power can be generated as water is released from the Coyote reservoir to supply these pumping plants. If this is done, the operating costs of the entire project will be extremely small. Estimates provide throughout for cement lined ditches, permanent construction, automatic pumping plants and power plant, and minimum inconvenience and disturbance to existing orchard improvements.

Surface reservoirs do not appear economical for watersheds furnishing about 41% of the runoff. All but 5% of this is on the seven watersheds of the Berryessa, Penitencia, Los Gatos, San Tomas, Campbell, Calabazas and Permanente Creeks. All feasible conservation on these seven streams will be accomplished, however, by check dams in the mountains and spreading dams and percolating dams in the stream beds on the Valley floor. Small rock check dams are proposed wherever feasible in the mountain watersheds of these seven streams to restrain and delay flood waves and assist in desilting the flood flow so as to increase the efficiency of the numerous

spreading dams and percolating dams projected for increasing the natural stream bed percolation of these various streams. Every recognized method of water conservation will be included in the treatment of these streams and particular care will be exercised to so design the structures so as to avoid silting of the stream beds. The Los Gatos is particularly important. Very extensive developments for this stream include three large percolating reservoirs between Los Gatos and Campbell. Special measures, including boulder percolating areas and percolating wells and tunnels are projected for the treatment of the Penitencia Creek, which has the largest proportion of natural waste of any of the main valley streams. The mountain check dams, "sausage" spreading dams and concrete percolating dams, which the district has already built are well designed and constructed and much more extensive use of the same kind of structures is recommended.

The following Table A is a summary of the water now wasted, which this project would salvage:

TABLE A

SUMMARY OF WASTE WATER SALVAGED

Column	Av. Nat. Absorp. Table 5 (1)	Av. Nat. Waste Table 5 (2)	Total Runoff (1)+(2) (3)	Salvage From Nat. Waste (4)	Total Avail. (1)+(4) (5)	Unsalvaged Remaining Waste (2-4) (3-5) (6)	Unsalvaged % of Runoff (6)÷(3) (7)
Coyote	20560	59820	80380	33560	54060	26320	33
Calero	.....	.....	.....	.....	.....	.....	...
Almaden	.....	.....	.....	.....	.....	.....	...
Guadalupe	10585	9185	19770	(6160)	(16745)	.....	...
" Incl. Per. Res.	.....	.....	.....	(2300)	19045	725	4
Stevens Creek	6930	12180	19110	4350	11280	7830	41
Total for Surface Res. Streams	38075	81185	119260	46310	84385	34875	29
Berryessa	1095	355	1450	180+	1275	175	29
Penitencia	1770	8150	9920	1800	3570	6350	64
Los Gatos	14900	27430	42330	8885	23785	18545	44
San Tomas	1550	550	2100	275+	1825	275	13
Campbell	6000	5880	11880	2885	8885	2995	25
Calabazas	1150	500	1650	250+	1400	250	15
Permanente	1195	1590	2785	400+	1595	1190	48
Total for Stream Bed Improvement	27660	44455	72115	14675	42335	29780	41
Total for Improve Stream	65735	125640	191375	60985	126720	64655	34
Untreated Watersheds	10750	410	11160	0	10750	410	4
Totals for Valley	76485	126050	202535	60985	137470	65065	32

The total indicated salvage is 60,985 acre ft. per annum. The project would increase the supply available for the Santa Clara Valley wells from the amount of the present natural absorption 76,485 ac. ft., to this amount plus the water salvaged by the project, 60,985 ac. ft. or to a total of 137,470 acre ft., an increase of about 80%. The project would thus salvage about 48% of the present natural waste, leaving unsalvaged 52% of the natural waste, or 32% of the total runoff.

The table indicates that the unsalvaged remaining waste is chiefly on the Coyote and Los Gatos creeks with lesser, but still very important amounts on the Stevens, Penitencia, and Campbell creeks.

It would be impossible to salvage all of the remaining average waste

as considerable portions of it occur during great floods in wet seasons and cannot be restrained. Additional supplies could be obtained, however, if ever required, by the district, in the distant future, by further reservoir development, particularly on the Coyote and Stevens Creeks.

The indicated salvage is about one-third more than the Division of Water Resources estimate of the overdraft in the subnormal last 16 years, and hence it might be inferred that even in continuous recurrent similar subnormal years, the proposed works would stop the decline of the water plane and might start it rising again about one-third as fast as it has been going down. During wet years, both the natural absorption and the salvage effected by the present project may each increase up to about 125,000 ac. ft. and in such years the water plane would remain about stationary without the present project, but would rise from 10 to 12 ft. with the present project in operation.

The principal wastage of water will be from the Penitencia, Los Gatos, Stevens and Campbell creeks. Every effort should be made to increase winter irrigation from these streams. All of them pass over porous ground where excessive supplies of winter water would not be injurious and would augment well replenishment as the excess eventually found its way into the underground gravel reservoir.

The estimated cost of the entire project is as follows:

Detention Reservoirs	$3,607,200
Distribution System	1,026,500
Power Development	370,448
Watershed and Stream Bed Improvements	495,852
GRAND TOTAL	$5,500,000

"The Progress Report on Santa Clara Investigation" January 1st to September 30, 1930, by E. N. Bryan, Hydraulic Engineer of the Division of Water Resources, prepared under supervision of Harold Conkling, Deputy State Engineer, has been of the utmost value in preparing this report.

The extensive report prepared ten years ago by the writer and Mr. Stephen E. Kieffer, Consulting Engineer, has been freely used in the preparation of this report. Mr. Ralph G. Wadsworth, Engineering Associate of the writer, has supervised the preparation of the cost estimates herein contained.

Acknowledgement is made of the continuous interest and assistance of Mr. Herbert C. Jones, Attorney, and Mr. Leroy Anderson, President of the District.

With extremely meager funds the works which the District has built under Mr. Anderson's direction, have been well designed and constructed and will be fully useful to the present comprehensive project.

The major works herein proposed are absolutely necessary to prevent final complete exhaustion of irrigation water supply over large portions of the District area.

The conclusions of this report represent the writer's technical familiarity with water use in the Santa Clara Valley for about 27 years and particularly most intensive studies during the last ten years.

Very respectfully,

FRED H. TIBBETTS, Chief Engineer,
Santa Clara Valley Water Conservation District.

CHAPTER I

WATER SHORTAGE

ESTIMATE OF STATE DIVISION OF WATER RESOURCES (44,000 Ac. Ft. per annum overdraft.)

Under date of August 18, 1931, the State Division of Water Resources advised as follows:

"STATE OF CALIFORNIA
Department of Public Works

Division of Water Resources,
401 Public Works Bldg.

Edward Hyatt, State Engineer,
Chief of Division.
Sacramento, California,
August 18, 1931.

SANTA CLARA VALLEY INVESTIGATION

Mr. F. H. Tibbetts, Chief Engineer,
Santa Clara Valley Water Conservation District,
95 Auzerais Bldg., San Jose, California.

Dear Sir:

In response to your request of August 11th we would advise that our investigation of water levels in the wells of the Santa Clara Valley reveal the following:

Average Depth to Ground Water in 1915— 33.4′
Average Depth to Ground Water in 1921— 63.4′
Average Depth to Ground Water in 1930— 97.9′
Average Depth to Ground Water in 1931—109.0′

There occurred a recession of 12.0′ between March 1, 1930, and March 1, 1931, which applying the assumption indicated on Pages 16 to 18, inclusive, of the Progress Report of November 1, 1930, on the Santa Clara investigation, indicates a further depletion in the ground water of the valley during the year of some 110,000 acre feet. The depletion during the 6 year period from 1915 to 1921, as indicated in the report, averaged 46,000 acre feet per year, and during the succeeding period of 10 years (1921 to 1931) averaged 43,000 acre feet per annum, or a gross depletion during the 16 year period of something in excess of 700,000 acre feet.

Very truly yours,
E. N. BRYAN,
Acting Deputy in Charge of Water Rights."

The average drop in the water plane during the last 16 years was 4.8 ft. per year and the average estimated ground water depletion or overdraft was about 44,000 acre feet per year.

ESTIMATES OF TIBBETTS & KIEFFER REPORT 1921

An exhaustive investigation of the water supply of Santa Clara Valley was made by Fred H. Tibbetts and Stephen E. Kieffer, Consulting Engineers in 1920 and 1921. Their report dated March 23, 1921, copies of which were filed with the County Board of Supervisors and the State Engineer, is now also available at the office of the Santa Clara Valley Water Conservation District and at the office of the City Manager of San

Jose. On Pages 15 and 16 of that report the average permanent drop in the water plane was estimated as four to five feet per year and it was predicted that with full development of the valley this would increase to 5¼ ft. per year unless remedial measures were undertaken which would prevent the wastage of large volumes of uncontrolled flood waters into San Francisco Bay. The verification by the skilled and disinterested experts of the State Engineer's office of the predictions made eleven years ago leaves no doubt regarding the fundamental scientific accuracy of the analytical methods previously used in making the predictions which are now verified. The conclusions of the Tibbetts and Kieffer report regarding the necessity of conserving the portion of the water supply from the watersheds naturally tributary to the valley, which is now wasted into the Bay, can, therefore, now be used with the utmost confidence and the vast amount of detailed analytical work of the former report need not be repeated here.

Tibbetts and Kieffer estimated the water demand of the district as then organized in 1920, as 137,000 acre ft. per annum. The present district has about 85% of the area then studied, and its 1920 water demand might be estimated as about 116,000 acre ft. per annum.

The total average natural stream bed absorption was estimated by Tibbetts and Kieffer as 89,000 acre ft. per annum, indicating that the water use exceeded the natural replenishment by about 48,000 acre feet per annum, (perhaps equivalent to 40,000 acre feet for the area of the present district).

Estimate of This Report—50,000 to 60,000 acre ft.

The Division of Water Resources estimates that the increase in irrigated acreage in the last ten years has been about 35% and that approximately 95,000 acres of district lands were irrigated in 1930. It is doubtful if the use of water has proportionately increased, because of the low price of agricultural products and the great physical difficulties encountered in portions of the valley in securing sufficient water due to the cost and expense of following up the rapidly declining water plane with new wells and new machinery. The natural replenishment has been subnormal during the last ten years of subnormal precipitation and there has undoubtedly been some increase in the use of water. The writer would be inclined to believe that the estimates of depletion or overdraft made by the Division of Water Resources are somewhat low and that a figure of 50,000 or even 60,000 acre ft. per annum for the past ten year dry decade would be more probable.

Disastrous Continuing Decline Certain.

As is subsequently shown, natural stream bed absorption during normal periods or wet periods, increases much less rapidly than does the total runoff. The "Profiles of Ground Water Levels" accompanying the Division of Water Resources report confirm the Tibbetts and Kieffer deductions that the decline of the water plane may be temporarily checked during seasons of excess rainfall, but that the water plane cannot be expected to rise. The two years, 1920 to 1922, were years of more than normal precipitation (Page 14, Division of Water Resources Report) yet the water plane failed to rise during these two years and resumed its rapid decline during the next season of a little less than normal rainfall.

It can be predicted with the utmost confidence that unless measures are promptly taken to prevent the waste of flood waters into the Bay, even the resumption of normal or wet seasons cannot effect material recovery of the water plane, which will continue to steadily fall whenever there are any more subnormal seasons. The 12 ft. drop during the last year is most remarkable and alarming. Both the area and porosity of the underground water storage basin are probably decreasing. Unless conservation measures are undertaken, nothing can prevent final destruction from failure of water supply, of large sections of the Valley. This fate has already overtaken, according to the State Engineer's estimates, a highly developed area of some 200,000 acres in the southern San Joaquin valley; an area which the State Engineer states "will go back to desert country", unless provided with additional water supply.

CHAPTER II

WATER SUPPLY

Surface Runoff

Normality of Period of Tibbetts & Kieffer Investigation.

Estimates of available water supply in the Tibbetts & Kieffer report were made with great care for the period 1902 to 1920. The precipitation in the Santa Clara Valley watersheds during that period was estimated to be 94% of the 71 year period for which records were then available. It included the two cycles of critically dry years of 1912-13 and 1918-1920. The following decade to date has somewhat reduced the normal or average rainfall during the period of record to date, so that the 18 year period analyzed in the Tibbetts & Kieffer report now appears to be one of almost exact average rainfall and presumably run-off, as the following table including the three most important weather bureau stations indicates:

TABLE I

PRECIPITATION 1902-20

San Jose	Los Gatos	Mt. Hamilton
Average precipitation 1874 to 1930 from Division of Water Resources Report Table 28:		
14.60 inches	32.02 inches	29.39 inches
Average precipitation for 18 year period 1902 to 1920, from Division of Water Resources Report.		
15.15 inches—104%	33.46 inches—105%	28.51 inches—97%
Average precipitation 70 year period 1849 to 1920 from Tibbetts & Kieffer, Table 6, Page 76.		
15.52 inches	32.85 inches	30.77 inches

As the foregoing table shows that the 18 year period analyzed in the Tibbetts & Kieffer report, was a period of almost exactly normal rainfall, the estimates of water supply contained in that report will be quoted herein unchanged.

WATERSHED AREAS

TABLE 2.

REGIONAL DISTRIBUTION OF TRIBUTARY WATERSHEDS (ADAPTED FROM TIBBETTS & KIEFFER TABLE 5, PAGE 74, EXCLUDING AREAS 1 AND 26 WHICH NOW FORM DISTRICT BOUNDARIES)

Section	Tributary Watersheds Square Miles Each	Totals	Percent of Total
East Side—Milpitas to Lower Gorge of Coyote (10 drainage areas. Exclude No. 1=.95)		73.52	16.7
South Side			
Coyote—above upper gorge	193.20	193.20	44.0
Coyote—below upper gorge	25.98		
Almaden	32.64		
Guadalupe	13.62	46.26	10.5
Miscel. (2 areas)	6.83	272.27	61.9
West Side			
Los Gatos	43.50		
San Tomas	5.09		
Campbell	11.48		
Calabazas	3.53		
Stevens	19.75	19.75	4.5
Permanente	7.90		
Miscel. (2 areas)	3.53	94.78	21.4
TOTAL		440.57	100.00
Surface Storage Areas		259.21	59.0

WATERSHED RUNOFFS

TABLE 3

SUMMARY OF AVERAGE RUNOFF FROM TRIBUTARY WATERSHEDS, 18 YEAR PERIOD, (ADAPTED FROM TIBBETTS & KIEFFER TABLE 11, PAGE 95,) (SEE PLATE 2 FOR LOCATION OF WATERSHEDS)

No.	Watershed Name	Average Rain Inches	Av. Seasonal Runoff Ac. Ft.
2	Calero	22.5	625
3		21.	175
4	Los Choches	23.	960
5		21.	140
6	Berryessa	24.4	1450
7		21.5	290
8	Penitencia	25.1	9920
9		21.5	310
10		22.	870
11	Evergreen	19.4	3470
12	Coyote	24.82	80380
12 a, d		18	2045
12 b		17.2	520
12 c		17.5	335
15	Almaden		
	Upper	35.6	6360
	Lower	23.4	4395
	Calero	24.1	2205
16	Guadalupe		
	Upper	32.8	3240
	Lower	25.8	3570
17	Los Gatos	40.7	42330
18		27.4	950
19	San Tomas	31.6	2100
20	Campbell	43.3	11880
21	Calabazas	33.4	1650
22		22.	155
23	Stevens		
	Upper	42.4	17580
	Lower	26.6	1530
24	Permanente		
	S. Fork	33.5	1560
	N. Fork	28.6	1075
	Lower	23.3	150
25		23.3	315
	TOTAL		202,535

The location of the watersheds is shown on the accompanying Plate 2, which is taken from Plate 8, Page 73 of the Tibbetts & Kieffer report.

A compilation from the foregoing tabulation of the runoff from the various watersheds shows the following regional distribution.

TABLE 4

SECTIONAL DISTRIBUTION OF AVERAGE ANNUAL RUNOFF (FROM TIBBETTS & KIEFFER TABLE 12, PAGE 109.)

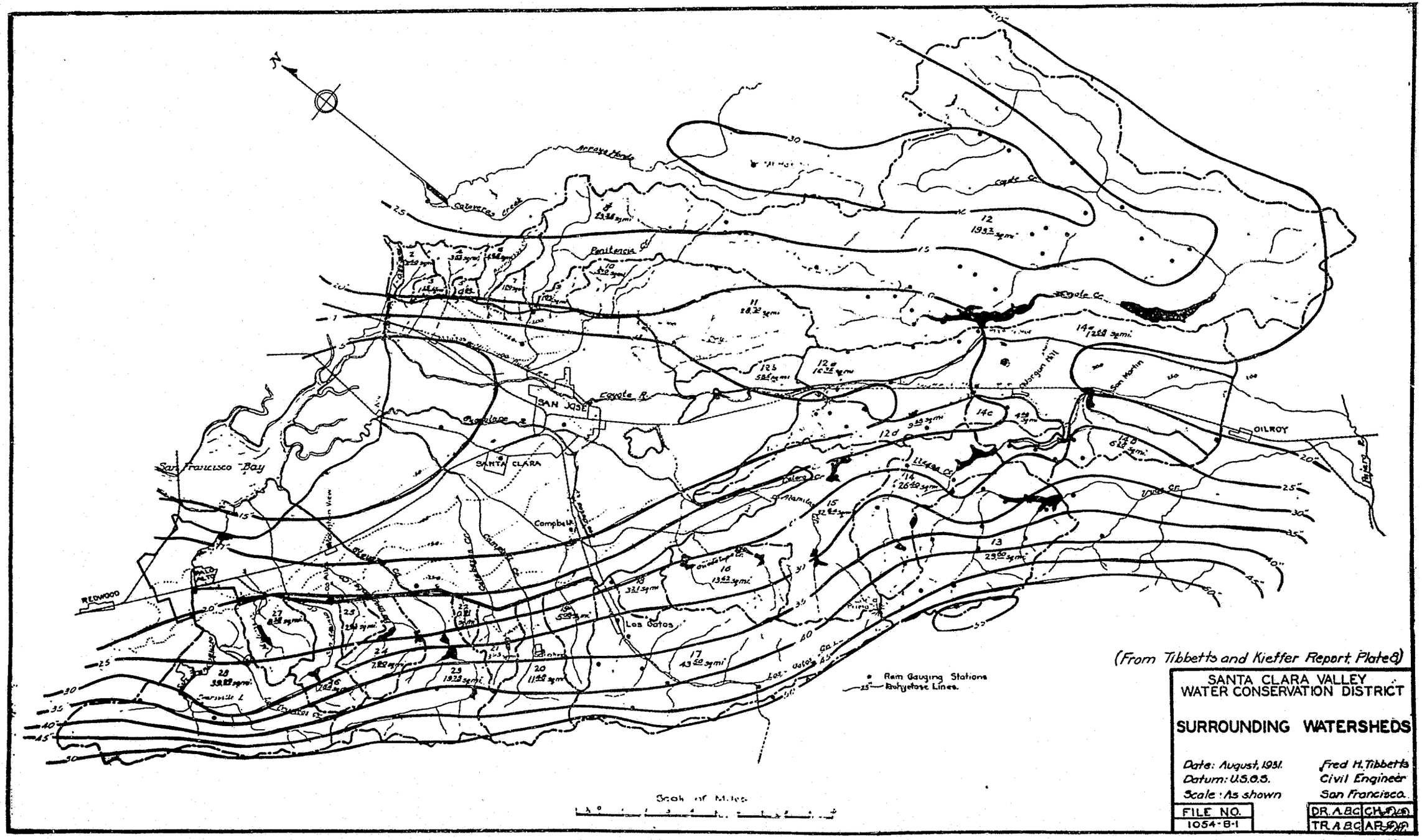
Section		Mean Seasonal Runoff, ac. ft.			Percentage of Total		
Main Valley North of Upper Gorge of Coyote, tributary to S. F. Bay							
East Side—Milpitas to Lower Gorge of Coyote (Areas 2-11)	18210	.....	.....	9.0	.....	.....
Berryessa	1450	.....	.....	1450	.....	.....	0.7
Penitencia	9920	.....	.....	9920	.....	.....	4.9
South Side							
Coyote—Above Upper Gorge (12)	80380	80380	.....	.....	39.6	.....
Coyote—Below Upper Gorge (12a, b, d)	2565	.....	.....	.....	.....	.....
Almaden (15)	12960	12960	.....	.....	6.4	.....
Guadalupe (16)	6810	6810	.....	.....	3.3	.....
Miscel. (12c, 18)	1285	.....	.....	.....	.....	.....
	104000				51.4	
West Side							
Los Gatos (17)	42330	.....	42330	.....	.....	20.9
San Tomas (19)	2100	.....	2100	.....	.....	1.0
Campbell (20)	11880	.....	11800	.....	.....	5.9
Calabazas (21)	1650	.....	1650	.....	.....	0.8
Stevens (23)	19110	19110	.....	.....	9.4	.....
Permanente (24)	2785	.....	2785	.....	.....	1.4
Miscel. (22, 25)	470	.....	.....	.....	.....	.....
	80325	.....	.....	39.6	.....	.....
TOTAL	202535	.....	.....	100.00	.....	.....
Storage Developments		119260	.....	.....	58.7	.....
Check Dam and Stream Bed Developments		.....	72115	.....	.....	35.6
All Developments		.....	191375	.....	.....	94.3

As shown in the Tibbetts and Kieffer report (Page 17), the runoff from the local watersheds tributary to Santa Clara Valley is just sufficient if fully conserved and stored in the vast, protected underground, gravel basins underlying the Valley to meet the probable future demands of the Valley when development is complete. As compared with the project of ten years ago the elimination from the present District of the Northwest or Palo Alto area, simplifies the problem. This area was the most difficult and expensive to supply with local water and because of its urban character, can best afford the high cost of an imported water supply if eventually required.

NATURAL UNDERGROUND WATER SUPPLY

Gravel Beds.

Underlying the agricultural areas of Santa Clara Valley are irregular and frequently discontinuous bodies of gravel, sand, and silt deposited by the wandering courses of the various streams draining the surrounding mountains. Between the gravel, stones, grains of sand, and particles of


N
Arroyo Honda
Calaveras Creek
Penitencia Cr.
Coyote Cr.
Coyote R.
SAN JOSE
Guadalupe
SANTA CLARA
San Francisco Bay
Guadalupe R.
Alamitos Cr.
Los Gatos Cr.
Los Gatos
Saratoga Cr.
Stevens Cr.
Permanente Cr.
Calabazas Cr.
Campbell Cr.
Ross Cr.
Silver Cr.
Lower Silver Cr.
Upper Silver Cr.
Miguelita Cr.
Arroyo Aguague
Arroyo Laguna
Arroyo Calero
Arroyo Del Agua Caliente
Arroyo Del Agua Caliente
Arroyo Del Agua Caliente

silt or clay, are irregular void spaces, aggregating from 10 to 50% of the total volume. A portion of the resulting porosity is available as storage and channel space for underground water, and it is from underground water bodies created in this manner that the well supply of the Valley used for irrigation is drawn. This under ground water supply should be considered partly as a vast reservoir, underlying the entire Valley, and partly as a very slowly and irregularly moving body of water generally flowing northerly or northwesterly towards San Francisco Bay.

Available Porosity.

In an underground water reservoir such as that underlying Santa Clara Valley, the amount of water which can be recovered by lowering the water plane any given amount, varies directly with the available porosity of the waterbearing materials. The total porosity of any soil or gravel formation is the ratio between the aggregate void space and the total volume of the material. This ratio may ordinarily vary in nature from about 10% to 50% or more. It depends chiefly upon the relative sizes of different grains composing the material.

Tibbetts & Kieffer estimated the average porosity of the Santa Clara Valley formations as 11.1%. The Division of Water Resources Progress Report estimates it as 10.6% and furthermore estimates that the underground reservoir created by the lowering of the water plane, which has occurred during the last sixteen years, has a capacity of about 700,000 acre ft. The total capacity of this underground reservoir is probably now close to one million acre feet.

Stream Action and Valley Building.

The soils in the Valley for great depths have been built up by periodical overflow from the principal streams, depositing gravel, sand, silt and clays. During this process the streams have many times swung back and forth from east to west pivoting on the apex of their gravel cones as defined by the lower ends of their canyons as they debouch from the mountains. Each one of the prehistoric river or stream channels has meandered toward the north in much the same manner as do the present channels, and each one of these old channels contains, just as do the present ones, long, narrow, winding, irregular gravel deposits in the bottom, sloping northerly and downward from the canyon mouths.

To properly understand the underground water conditions and soil conditions, however, one must imagine many now buried surfaces similar to the present one, and each with its quota of winding, fan-like ancient channels, radiating northward and downward. The porous gravel and sand deposits in the present channels and in each of these ancient channels were not uniform or continuous, for any great distances. As the old stream beds were successively filled up by fresher silt deposits, the porous gravel and sand strata became separated and enclosed by tighter silt or clay formations.

In the normal process of building up a Valley of this sort each of the various streams occupies one channel for geologically speaking, a very limited time. During floods when they carry much sand and silt, the waters overflow the channels and as they overflow spread out in thin sheets, the velocity is checked, and the sand and silt deposited. In due course of time the heavier materials being deposited first, and closest to

the banks, gradually build up the banks until the streams occupy ridges higher than the adjacent land. In times of great floods, they will then suddenly cut new channels through these ridges and, seeking lower ground, will completely abandon their old channels, leaving in most of their beds, long, winding, narrow, deposits of porous sand or gravel, which in their turn eventually become buried and enclosed in fresh deposits of silt and clay deposited by stream overflow from new channels.

Delta Cones.

The delta cones of the principal streams such as the Coyote, Guadalupe, Los Gatos and Stevens creeks must then be visualized as masses of gravel, sand, silt and clay deposited by the streams and permeated throughout, horizontally and vertically with more or less interconnected long, winding, narrow, slender, porous strata and stringers of gravel or sand, all radiating in a general northerly direction downward through the Valley fill from the large porous deposits of gravel now occupying the lower ends of the canyons as the streams emerge upon the Valley floor. These bodies of gravel and sand form the remains of ancient river or stream channels and like a series of imperfect pipes conduct water percolating from the bottoms of the various streams throughout all parts of the Valley formations underlying the District. They are technically termed "Aquifers",—porous bodies, acting as storage reservoirs as well as conduits for the slow diffusion of underground water.

There are so many of these aquifers at various elevations that wells bored at random anywhere in the Valley are very apt to strike one or more of them, as indicated by gravel and sand strata, and thus derive a well supply replenished normally by stream bed percolation as well as by the surrounding more or less inter-connected aquifers, which being close together also drain out the surplus water from the silt and clay soils by which they are enclosed. It can readily be seen that normal wells drawing and supplied from aquifers of this type will get a portion of their supply directly during the pumping season from underflow conducted from the streams near the heads of the gravel cones, and will get the balance of their supply from water stored in the aquifers which they penetrate and which drain the surrounding soils.

As the streams deploy from their various canyon mouths the larger bodies of gravel, as well as the bodies of coarser gravel, are more or less left behind at the upper ends of the delta cones along the margin of the Valley. There are large, almost continuous bodies of coarse gravel, cobbles and boulders such as found at the surface of the present channels, particularly noticeable on the Penitencia, Coyote, Guadalupe, Los Gatos, San Tomas, Campbell and Stevens Creeks. As the aquifers fan out toward the valley floor they not only become farther apart following the fan shaped deltas, but they also tend to become smaller, narrower and composed of finer materials until they either fade out completely or are buried and terminated in the tight impervious clays overlying the water bearing materials at the lower end of the Valley.

STREAM BED PERCOLATION

Ground Water Contours.

The Progress Report of the Division of Water Resources on the Santa Clara investigation contains an excellent map showing the position of the ground water contours. Of great significance in this map is the drop of the ground water contours as the main streams cross the upper and porous ends of their gravel cones as just described. The rapid drop in these ground water contours indicates a rapid flow of percolating underground water from the creek beds in these vicinities. It has great importance in revealing the portions of the stream bed areas, receptive to percolating stream flow and thus particularly adapted to structural measures intended to artificially augment stream bed percolation. Such measures to be effective, must be confined to those portions of the stream beds which the rapid drop of the ground water contours reveal as receptive to augmented percolation and distribution of underground water supplies.

Coyote River.

The ground water contours along the lower Coyote from the Lower Gorge to Edenvale are peculiar and of great significance. They conclusively indicate that the escape of water by percolation from the bed of the Coyote is confined to the portion of the stream bed between the Upper Gorge and the Edenvale Narrows. They indicate a heavy underflow through the Lower Gorge, a rapid diffusion of this underflow westward, between the Lower Gorge and the Edenale Narrows and the final passage of these escaping waters in great quantity between the Cemetery and Edenvale groups of hills, where they pass beneath an enormous impervious clay blanket and supply the wells northeast, east, southeast and south of San Jose. No escape from the stream bed is indicated below the Edenvale Narrows and little or no movement of underground water, under present conditions at least, is indicated westward or toward the areas of greatest water depletion, beyond Campbell. The evidence is almost conclusive that for long periods of time the principal course of the Coyote River was between the Edenvale and Cemetery groups of hills, where doubtless it has deposited enormous bodies of porous gravel. There is no indication of aquifers leading from the Coyote toward the west and no probability of appreciable transfer of underground water from the Coyote across and underneath the Guadalupe.

Clay Blanket at Lower End of Valley.

There is abundant geological evidence that the main floor of the Valley has repeatedly risen and fallen above and below sea level and the probabilities are that during long periods of quiescent marine submergence, the extensive blankets of impervious clay found along the northern margin of the Valley were deposited and now prevent stream bed percolation to the well supply gravels from the lower portions of the Valley streams and also prevent the final escape under the bottom of the Bay of any considerable portions of the Santa Clara Valley well supply. Waste is confined to such flood waters as escape in the surface channels flowing over these clay deposits, such flood waters being the waters which this entire project is particularly designed to detain until they can be passed into underground storage through the porous upper portions of their stream beds.

REPLENISHMENT OF UNDERGROUND WATER

Penetration of Rainfall in the Valley Floor.

The Division of Water Resources report Page 10 states as follows:

"In April, 1930 tests were made by the Division of Agricultural Engineering, U. S. Department of Agriculture, for the purpose of establishing the extent to which penetration of rainfall on the Valley floor was effective as a contributor to ground water. These tests confirm tentative conclusions previously reached by Dr. F. J. Veihmeyer (Helgardia Vo. 2, No. 6) that there is no material contribution to the ground water by direct penetration of rainfall upon the Valley floor on ordinary soils."

Water Supply From Local Sources.

The Tibbetts and Kieffer report, Pages 116 to 117, states as follows:

"The geology of the entire San Francisco Bay region, clearly indicates at once that there is no reasonable possibility of any of the underground water of the Santa Clara Valley coming from any distant source.

Practically the entire supply then of the underground water basins which feed the wells so extensively used for irrigation in Santa Clara Valley is derived from percolation from the stream beds flowing through the Valley, and frequently directly continuous with the underground gravel beds, especially towards the margin of the Valley.

STREAM BED ABSORPTION. Factors of Analytical Determination.

The total amount of water normally passed into the underground gravels from each of the stream beds is capable of fairly accurate analysis, although such analysis requires a large amount of complicated and detailed field and office work. A complete estimate of the total amounts of water which naturally replenishes the underground gravel beds, and which theoretically could be recovered by the complete development of pumping plants, has formed one of the important lines of investigation of the present report. There are three basic factors involved in such an investigation.

First. The total flow of each stream into the Valley and for more detailed work, the daily or at least the average monthly flow; this factor having been deduced in the first portion of this chapter.

Second. The areas in each stream bed naturally exposed to absorption. This factor has been determined from detailed field surveys of each stream, and a careful reconnaisance of the character of each, by the writers.

Third. The unit rate (depth per day, or acre feet per acre per day) at which the gravel beds in the streams are capable of absorbing stream flow and passing it on to the underground gravel reservoirs. This last factor has been estimated from numerous measurements on different streams, of the actual amounts of water lost during the passage of the stream flows down measured portions of the creek beds."

The Division of Water Resources Report gives the measured stream bed absorption for the Coyote River between the Upper Gorge and Edenvale as averaging 15,200 ac. ft. for the subnormal 24 year record period at Madrone.

Appendix C of the Division of Water Resources Report also gives a number of measurements of absorption rate in the Guadalupe, Campbell and Stevens Creek and in the Coyote River during the winter of 1930.

Waste Water.

Table 5 shows the estimate in the Tibbetts & Kieffer report of natural runoff and natural stream bed absorption.

TABLE 5

STREAM BED ABSORPTION AND WASTE, ADAPTED FROM TIBBETTS AND KIEFFER TABLE 15, PAGES 123 and 124.

STREAM	Length Miles	Area Acs.	Assmd. Abs. Rate s.f./ac.	Average Runoff Ac. Ft.	Absorption in ac. ft. Max.	Min.	Aver.	Aver. Absorpn. %	Aver. Waste Ac. Ft.
East Side									
Areas 2-5 & 7		.....	.....	2190	3700	260	1780	81	410
Berryessa Ck. 6		.....	.....	1450	2200	200	1095	75	355
Penitencia Ck. 8	2.6	9.0	1.0	9920	3020	615	1770	18	8150
Areas 9-11		.....	.....	4650	10550	250	4650	100	0
Sub-Total		.....	.....	18210	19470	1325	9295	51	8915
South Side									
Coyote 12		.....	.....	80380	30800	3845	20560	25	59820
Coyote, 12a, b, d		.....	.....	2565	5835	110	2565	100	0
Almaden 15	0.5	.....	2.5)						
Guadalupe 16	7.3	.....	1 to 2)	19770	17535	2840	10585	54	9185
South Side 12c, 18		.....	.....	1285	2770	120	1285	100	0
Sub-Total		.....	.....	104000	56940	6915	34995	34	69005
West Side									
Los Gatos 17	9.4	.....	1.0	42330	24475	4470	14900	35	27430
San Tomas 19	8.1	17	2.17	2100	3020	300	1550	74	550
Campbell 20	6.2	24.2	2.4	11880	9650	1410	6000	51	5880
Calabazas 21	6.0	11.2	2.2	1650	1850	300	1150	70	500
Stevens 23	6.9	33.4	1.17	19110	10975	2260	6930	36	12180
Permanente 24	2.9	4.4	1.7	2785	1931	370	1195	43	1590
West Side 22, 25		.....	.....	470	1095	10	470	100	0
Sub-Total		.....	.....	80325	52996	9120	32195	40	48130
GRAND TOTALS		.....	.....	202535	129406	17360	76485	38	126050

The foregoing Table 5 indicates that under average conditions the annual runoff into the District should be 202,535 acre feet per annum, of which 76,485 acre feet or 38% is naturally absorbed through the stream beds into the underground gravel reservoirs from which the irrigation wells draw their supply. The balance of the runoff, except for such small amounts as are sometimes used for surface irrigation, is wasted into the Bay. This annual waste is 126,050 acre feet or 62% of the total runoff. This enormous waste, sufficient to cover the entire District annually to a depth of 11½ inches, is the block of water which any conservation Project must be designed to intercept and put to beneficial use.

The Water Conservation Project here proposed will include large surface storage or detention reservoirs on the Coyote, Almaden, Guadalupe and Stevens Creeks. 81,185 acre feet or 64.5% of the total waste of 126,050 acre feet occurs from these streams which it is proposed to control by surface reservoirs.

44,455 acre feet or 35.2% of the total waste is from the Berryessa, Penitencia, Los Gatos, San Tomas, Campbell, Calabazas, and Permanente Creeks. These are the creeks for which the Conservation Project proposes intensive development of check dams in the mountains for retarding and prolonging the runoff and spreading dams on the valley floor for sinking additional amounts of runoff into the underground reservoir.

On the small marginal streams, which constitute the balance of the watershed, having an aggregate runoff of 11,160 acre feet or 5.6% of the total runoff of 202,535 acre feet less than 1% of the total average annual waste occurs, and is unrestrained, by the present project.

The Conservation Project now proposed will then attempt to conserve wasted runoff from eleven of the larger streams, which produce 191,375 acre feet or 94.4% of the total runoff and from which the average annual waste is nearly 126,000 acre feet or over 99% of the total average annual waste.

CHAPTER III

STORAGE OR DETENTION RESERVOIRS

Functions of Detention Reservoirs

The principal wastage of water from the Santa Clara Valley occurs during infrequent, but heavy, floods of short duration. The only possible way to save large volumes of flood water during such periods is to provide surface reservoirs to detain the heavy flood flows until they can be transferred through canals of feasible capacity, into the porous, valley marginal, creek bed areas, which will in turn transfer them to the underground gravel storage reservoir.

There are 15 known reservoir sites on streams tributary to this district. All of these sites were surveyed and for all of them dams were designed, and cost estimates prepared and given in the Tibbetts & Kieffer report. The present project recommends the construction of five of these reservoirs and dams. The five reservoirs selected are those which provide the most economical storage, particularly, per acre foot of water salvaged. During the preparation of this report all of these sites have been again

inspected and new designs and estimates prepared for the dams and other works proposed. In connection with these reservoirs, distribution works are provided, which would empty the reservoirs when completely full, within five months. All of the reservoirs should be considered as "detention" rather than "storage" reservoirs; their primary function being to prevent flood waters wasting into the Bay by detaining or temporarily storing them until such time as they can be transferred into underground storage. The transfer should always be made, i. e., the reservoirs should be emptied, as rapidly as possible. Using them in this fashion there will be many seasons in which the aggregate amount of water intercepted and thus changed from wasted water to utilized water, will be much greater than the aggregate capacity of the reservoirs themselves. Especially in seasons of early rainfall the reservoirs may be partially filled and emptied several times in a single season. With this method of use, the reservoir losses from evaporation will be small. The primary storage of this project will be in the underground gravels of the valley, protected from evaporation and seepage losses.

The design and location of the dams and other structures projected in this report may both be changed if further studies, foundation tests, additional surveys, unforeseen contingencies or the best interests of the District indicate the desirability of so doing.

Final plans for all dams must by law be examined and approved by the State Engineer before the dams can be built.

RESERVOIR SERVICE

The following table gives the principal service features of the surface or detention reservoirs proposed:

TABLE 6

SURFACE OR DETENTION RESERVOIRS

RESERVOIR	Watershed Area Above Reservoir Square Miles	Average Runoff	Average Natural Waste, Ac. Ft.	Average Salvage, Ac. Ft.	Storage Capacity, Ac. Ft.	Ratio of Storage Cap. to Total Stream Runoff
Coyote	193.20	60,380	59,820	33,500	60,000	.75
Calero and Upper Almaden	(17.58)	(8,565)	.....	.....	(11,500)	1.34
Guadalupe	(5.66)	(3,240)	.....	.....	(3,500)	1.08
Guadalupe, Calero and Upper Almaden	23.24	11,805	.....	(6,160)	15,000	1.28
Guadalupe, Calero and Almaden, including Guadalupe Percolating Reservoir	(46.26)	19,770	9,185	8,400	.....	.76
Stevens, above reservoir	17+	.....	.....	.....	.....	.....
Stevens, Total	19.75	19,110	12,180	4,350	4,000	.21
TOTALS	259.21	119,260	81,185	46,310	79,000	.66
Above Reservoirs	233+					

Reference to the previous Tables 2 and 4 shows that surface storage is proposed on streams whose watershed area aggregates 59.0% of the total and whose runoff aggregates 58.8% of the total runoff. The efficiency of

the three surface reservoirs of the Guadalupe group will be augmented by the fine percolating reservoir at the junction of the Guadalupe and Almaden Creeks and hence the cost of, and service from, this percolating reservoir is included with the Guadalupe system.

DAMS

Design

All five of the dams selected have foundation conditions generally similar. Rock, where found, is soft and broken shale. It may be possible that the Almaden and Guadalupe dam sites may be excavated to rock sufficiently firm to provide satisfactory foundations for rock fill dams. This is doubtful and could only be determined by extensive test tunnels, pits, and borings. Estimates have been based upon the construction of earth, and rock dams of the standard but liberal cross-section shown on Plates 4, 6, 8, 10, and 12. At three of the dams, the Coyote, Guadalupe, and Almaden, the spillways will be excavated in rock and sufficient rock will be obtained to provide a heavy blanket upon the down stream portion of the dam. Where a considerable portion of the dam can thus be made of rock, the slope on the rear will be reduced to one on 2½. The Calero and Stevens creek dams will be all earth, and the rear slopes will be one on three. Estimates provide for 12 and 10 ft. freeboard for the Coyote and Calero dams and seven feet for the three smaller Almaden, Guadalupe and Stevens creek, dams. Material in the body of the dams will generally be placed by the dry fill method, spread in layers, watered and thoroughly rolled and compacted. The water slope will be covered with a heavy blanket of especially selected impervious clay, sand and gravel, and then paved with asphalt or concrete for protection against wave wash. Before placing the body of the fills, surface material will be removed and a deep cutoff trench constructed under the front slope of each dam.

Spillways.

The spillway or wasteway is a very important portion of any earth dam. It will be the principal item of cost for some of the dams proposed, especially the Coyote. Since the failure of the St. Francis dam and the assumption by the State, in the interest of public safety, of responsibility for failures of dams, extraordinary precautions are being enforced in California. Tentatively the spillways for the dams here proposed have been designed for an average capacity of about 300 sec. ft. per square mile of watershed area and will be capable of discharging flood water at this rate, and still leave the tops of the dams five feet above water. The capacity of the Coyote spillway, 60,000 sec. ft., is, of course, many times greater than any recorded flood and probably three or four times as great as the channel of the Coyote can carry at San Jose. With such ample spillway provision there can be no possibility whatever of the safety of the dams being impaired during extraordinary floods.

Tunnel outlets with suitable control valves and additional emergency gates will be provided for all of the dams.

Coyote Dam (Figure 1, Plates 3 and 4.)

The Coyote dam at the Upper Gorge site will be the major structure of the entire project, controlling as it does about 44% of the total watershed. The 60,000 acre ft. capacity proposed, would have salvaged the entire waste

during the last ten years according to the Division of Water Resources Report which also estimates that it would have salvaged 700,000 acre ft. of water during the twenty-four years, 1903-1912 and 1916-1930, an average of 29,000 acre ft. per year or 71% of the waste during that period. Based upon the Division of Water Resources normal runoff for San Jose and Mt. Hamilton, this was a subnormal period of 93% of normal rainfall. During the period of average rainfall analyzed in the Tibbetts & Kieffer report it is estimated that this reservoir would have salvaged 56% of the normal wastage of 59,820 acre ft. per year or an average of 33,500 acre ft. per year.

Tunnel outlets of large capacity are proposed at stream bed elevation 420, and at elevation 540. 40,000 acre feet or 2/3 of the storage capacity is above this higher elevation. This would be the diversion height for the power canal.

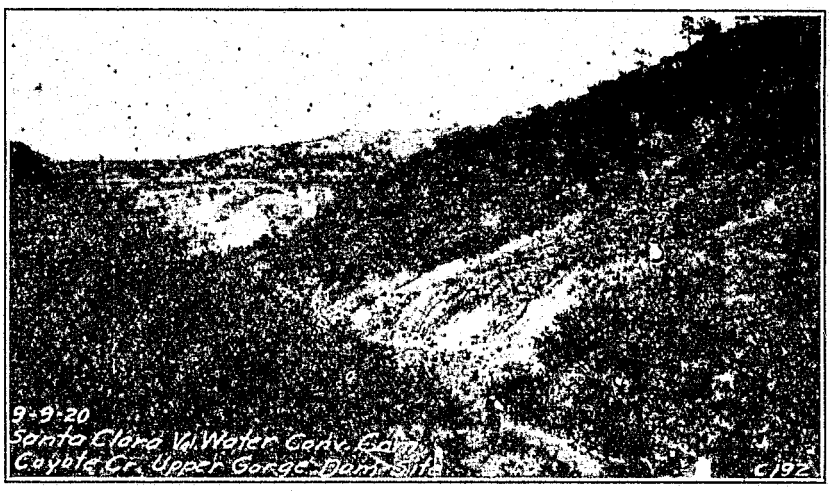


FIG 1. COYOTE DAM SITE



FIG. 2. ALMADEN RESERVOIR SITE.



FIG. 3. GUADALUPE DAM SITE.



FIG. 4. STEVENS CREEK RUNOFF. (Near Upper End of Reservoir Site.)

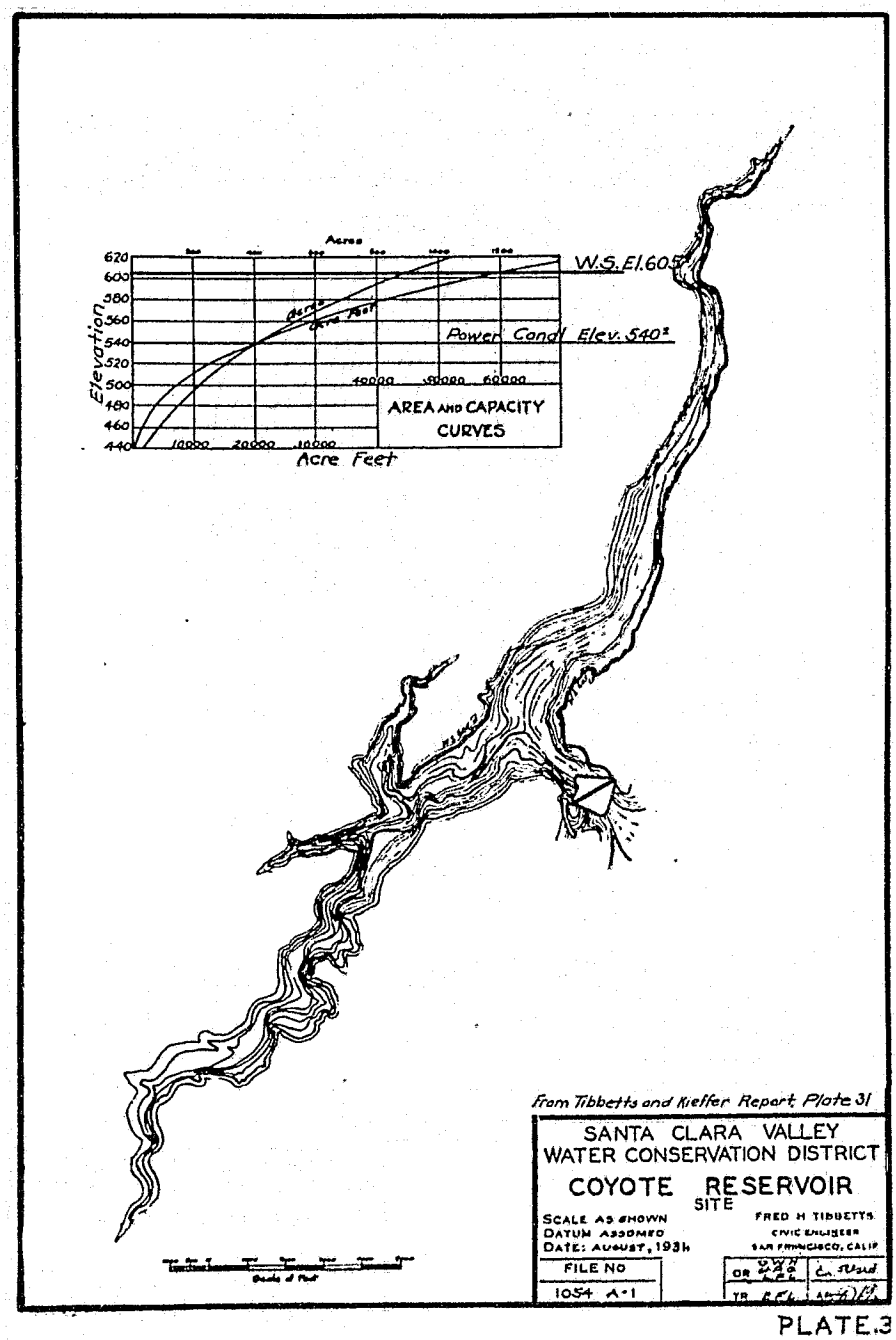

Acres
Elevation
620
600
580
560
540
520
500
480
460
440
W.S. El. 605
Power Cond. Elev. 540
AREA AND CAPACITY CURVES
Acre Feet
10000
20000
30000
40000
50000
60000
From Tibbetts and Kelfer Report, Plate 31
SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT
COYOTE RESERVOIR SITE
SCALE AS SHOWN
DATUM ASSUMED
DATE: AUGUST, 1934
FRED H TIBBETTS
CIVIL ENGINEER
SAN FRANCISCO, CALIF.
FILE NO
1054 A-1

PLATE.3

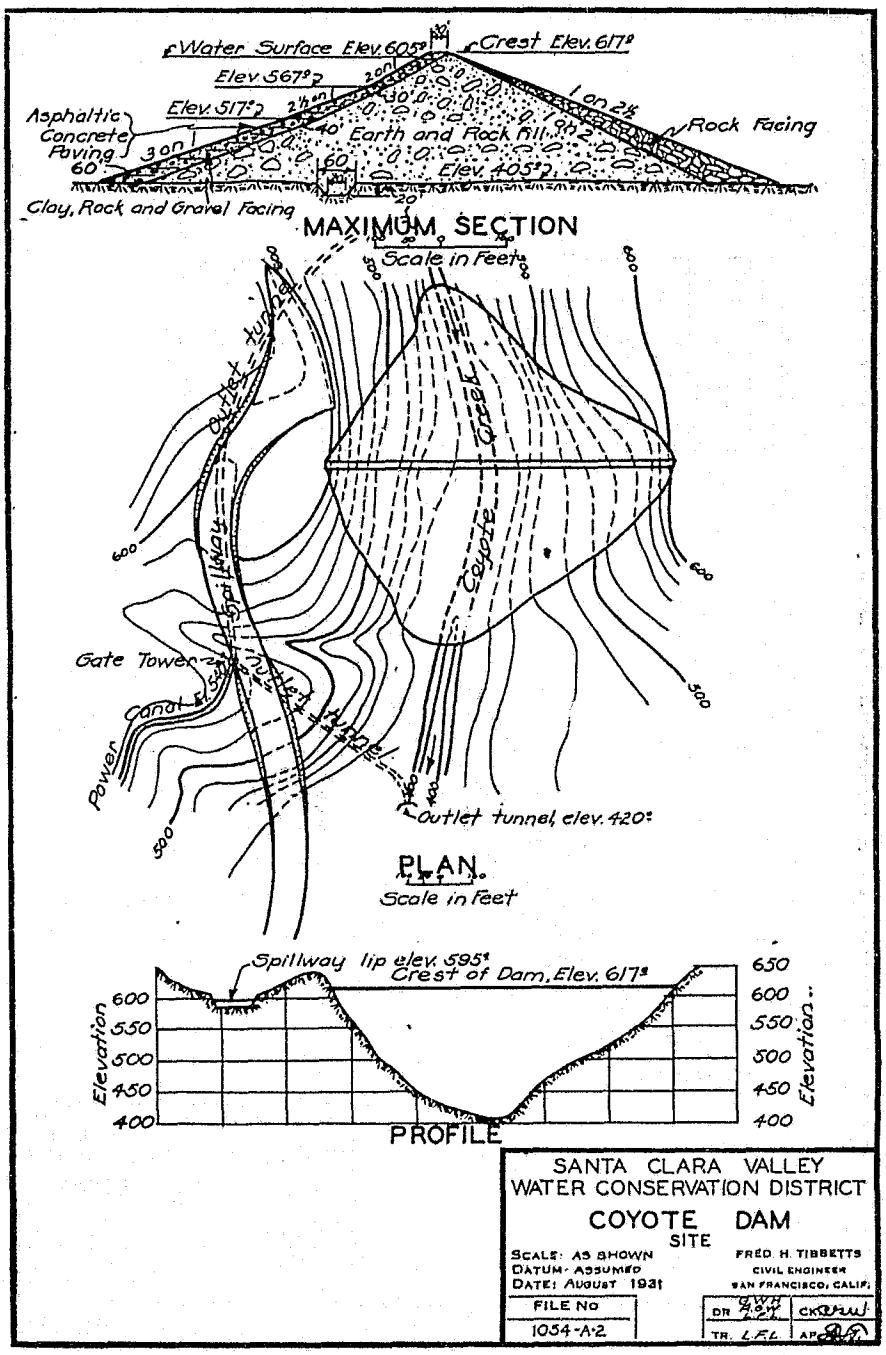

Water Surface Elev. 605?
Crest Elev. 617?
Elev. 567?
Elev. 517?
Asphaltic Concrete Paving
Earth and Rock fill
Rock Facing
Clay, Rock and Gravel Facing
Elev. 405?
MAXIMUM SECTION
Scale in Feet
Outlet tunnel
Spillway
Coyote Creek
Gate Tower
Power Canal
Outlet tunnel, elev. 420?
PLAN
Scale in Feet
Spillway lip elev. 595?
Crest of Dam, Elev. 617?
Elevation
PROFILE
SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT
COYOTE DAM
SITE
SCALE: AS SHOWN
DATUM: ASSUMED
DATE: AUGUST 1931
FRED. H. TIBBETTS
CIVIL ENGINEER
SAN FRANCISCO, CALIF.
FILE NO
1054-A-2

PLATE 4

As soon as the stored water reaches this elevation, 20,000 acre ft. in storage in the bottom, 140 ft. of the reservoir will normally be reserved for release for Coyote Gravel replenishment. The balance of the storage collected may be diverted through the power canal, passed through the power plant and released into the Coyote to be re-diverted at the Edenvale Narrows and pumped by the power generated in the power plant into the West Side and the East Side canals.

If needed, a by-pass channel will be provided between the power plant and the river in order to control transit losses above the lower gorge. This will consist of a simple earth canal paralleling the river between the river and the hills to the East. Water which has passed through the power plant will flow through this by-pass whenever it is apparent that this upper section of the Coyote Valley would otherwise be receiving too much water. This may be extended even further north if it becomes necessary also to prevent injury of lower Coyote area lands from too much water.

It is proposed to convey all releases from the big Coyote reservoir through the Coyote Valley as far as the Narrows. The Coyote Valley wells are certain to recover faster than those in other parts of the District. Even so it may be desirable, during the first few years of operation of the project, to pass through the reservoir while the first 20,000 acre feet is accumulating each year, sufficient of the natural early season stream flow to keep the Coyote channel wet. Farther study may even indicate the desirability of placing the power plant at the foot of the dam and designing it as a variable head plant.

The spillway will be excavated around the north abutment of the dam through rock which appears to be fairly hard. The excavated rock will be used for the lower portion of the dam.

Estimates provide for the acquisition of a large orchard in the reservoir floor and for relocation of the highway.

Alternative plans and estimates have been prepared at the suggestion of Consulting Engineer Harry Haehl for raising the Coyote Dam 15 feet, thus increasing the storage to 75,000 acre feet. This would add an average of 4,500 acre feet to the average waste water salvage of the Coyote. This enlargement of the Coyote reservoir may be substituted for the proposed Stevens Creek reservoir if as explained later the presence of the San Andreas fault and the Santa Clara geological formations in Stevens Creek Canyon finally cast any doubt on the safety of any water storage on Stevens Creek or alternative adjacent water sheds.

Calero Dam, (Plates 5 and 6).

This will be located on Calero Creek a branch of the Almaden Creek, about 2½ miles above the old Almaden Railroad station. A broad, flat valley can be closed by a dam 90 ft. high, creating a reservoir impounding 9,000 acre ft. of water. A secondary embankment 30 ft. high, will be required to close the saddle through which the highway now passes southeast of the main dam. The spillway will be located around the southern end of this secondary dam, requiring the relocation of the highway for about a mile, both above and below the spillway. The main dam will be a dry fill earth dam, there being an abundance of suitale material at the dam site.

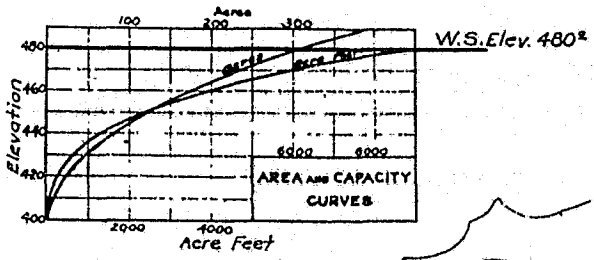
Almaden Dam, (Figure 2, Plates 7 and 8).

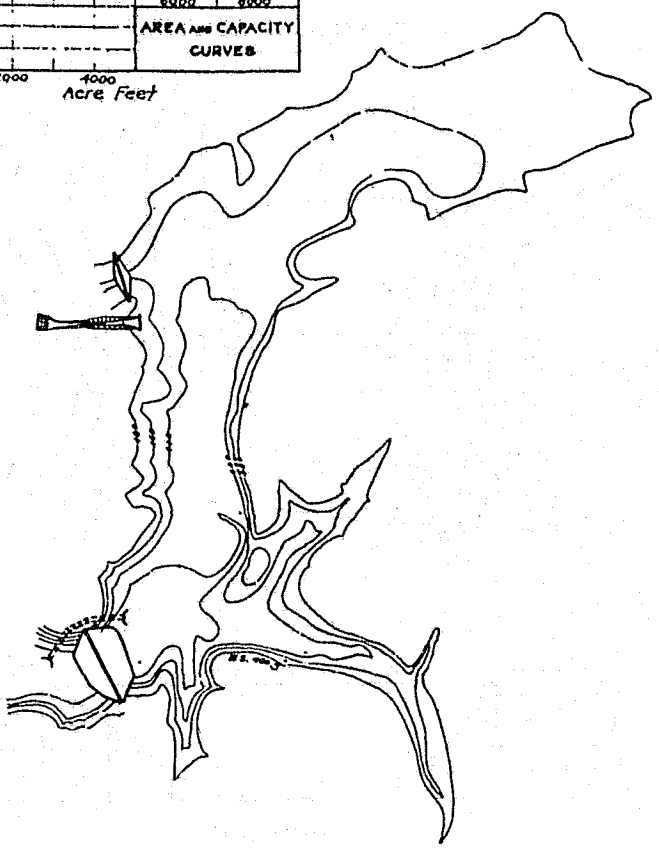
This will be located a short distance above Cannon's resort, a mile or more above the Almaden mine. There will be created a narrow canyon reservoir impounding 2,500 acre ft. of water.

The watershed above the Calero reservoir is small in comparison with its storage capacity and that above the Almaden reservoir, is large. It is hence proposed to operate the two as a unit. A sidehill canal of 100 sec. ft. capacity will be constructed from the Almaden dam to a ¾ mile tunnel which will divert the water into the Calero reservoir, transferring at each flood the excess water from the small Almaden to the large Calero, reservoir. All estimates of cost and of service from these two reservoirs should then include the connecting conduit and the two should be considered as one development.

The Almaden dam was proposed ten years ago as a masonry dam. Foundation tests might reveal the economy of building a rock fill dam at this site; possibly even a concrete dam, at a cost less than that proposed for an earth and rock fill dam of standard cross sections, especially as it may be necessary to go considerable distances to find enough suitable earth. There will certainly be sufficient good rock obtainable to cover the lower portion of the dam which can thus take the steeper slope of 1 on 2½. There are a number of resorts which will be submerged and the cost of acquiring these is included in the estimates.

After foundation tests have been made it is likely that alternative bids should be received on two or more different designs of dams of different types for both this and the Guadalupe dam.





From Tibbetts and Kieffer Report Plate 39

SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT

CALERO RESERVOIR SITE

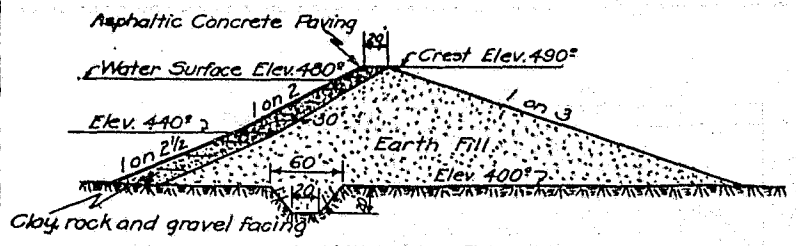
SCALE AS SHOWN
DATUM ASSUMED
DATE: AUGUST, 1931.

FRED H TIBBETTS
CIVIL ENGINEER
SAN FRANCISCO, CALIF.

FILE NO. 1054-A-3

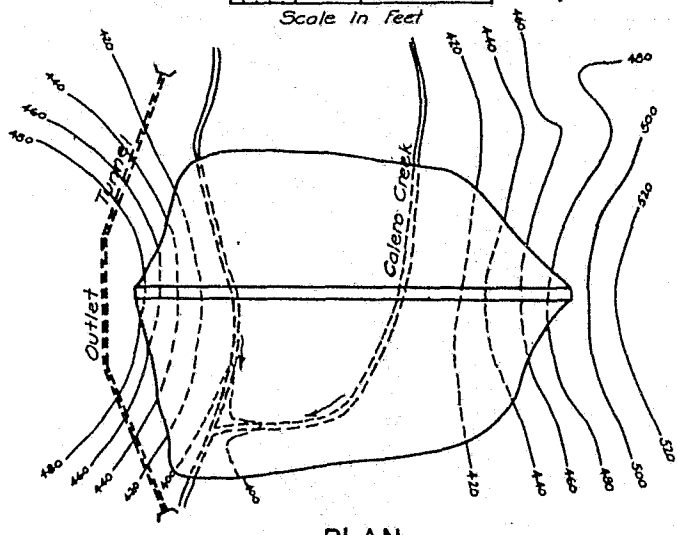
DR. E.W.H. A.C.A. CK. R.S.W.J.
TR. L.F.L. AP. F.H.T.

PLATE 5



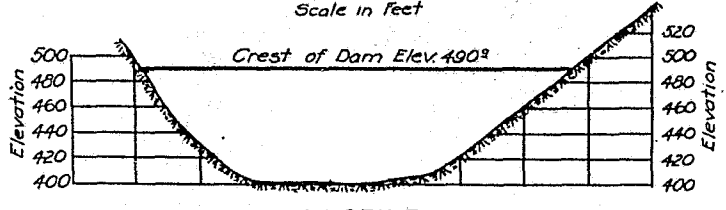
MAXIMUM SECTION

Scale in Feet



PLAN

Scale in Feet



PROFILE

SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT

CALERO DAM
SITE

SCALE: AS SHOWN
DATUM: ASSUMED
DATE: AUGUST, 1931

FRED. H. TIBBETTS
CIVIL ENGINEER
SAN FRANCISCO, CALIF.

FILE NO.	DR. GWH	CK.
1054-A-4	TR. LFL	AP.

PLATE 6

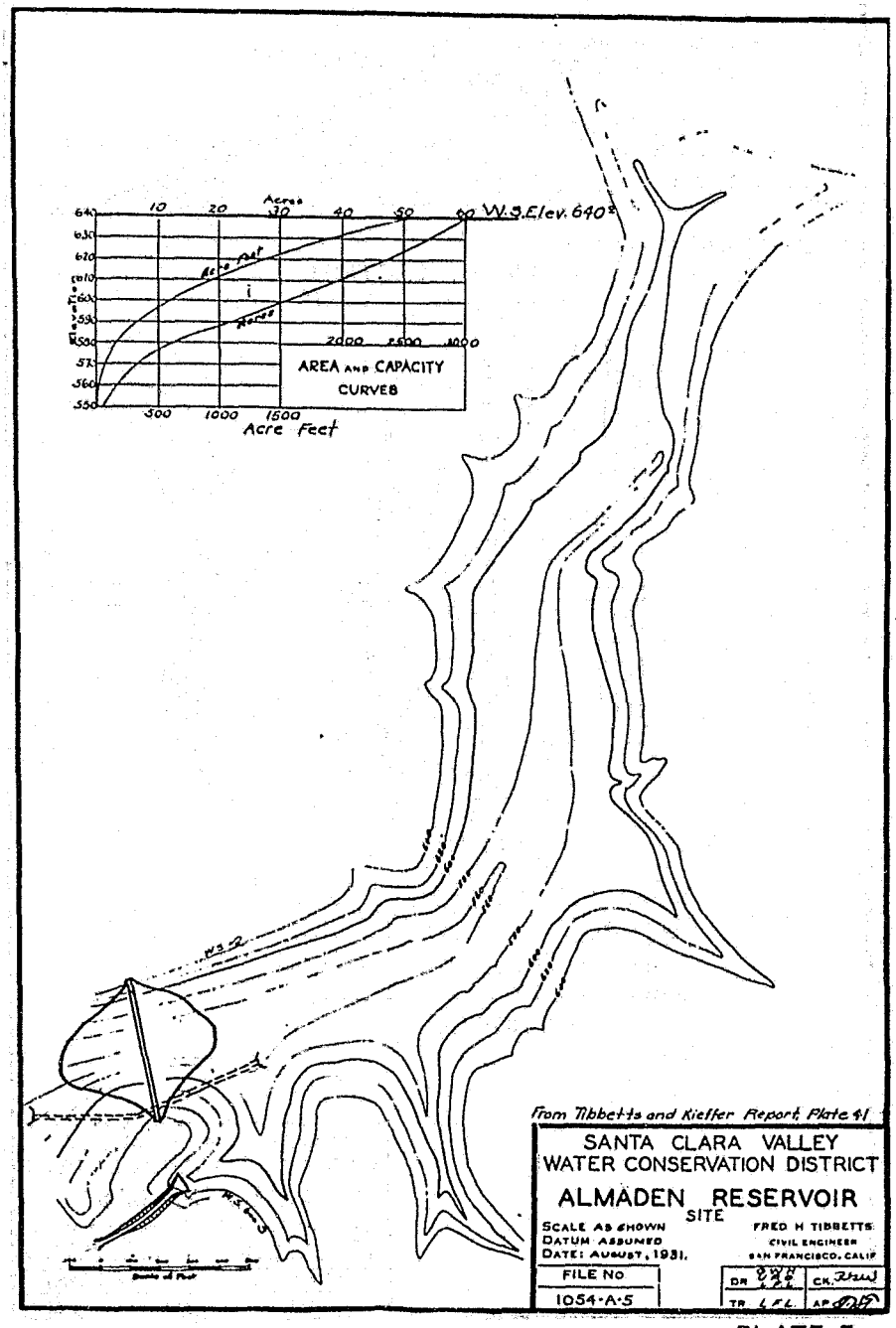
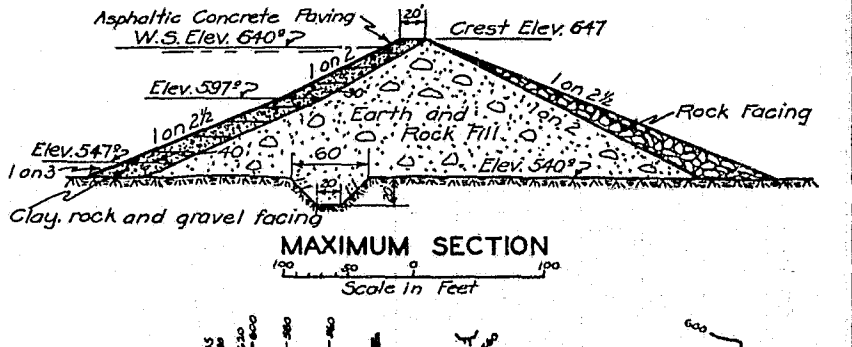
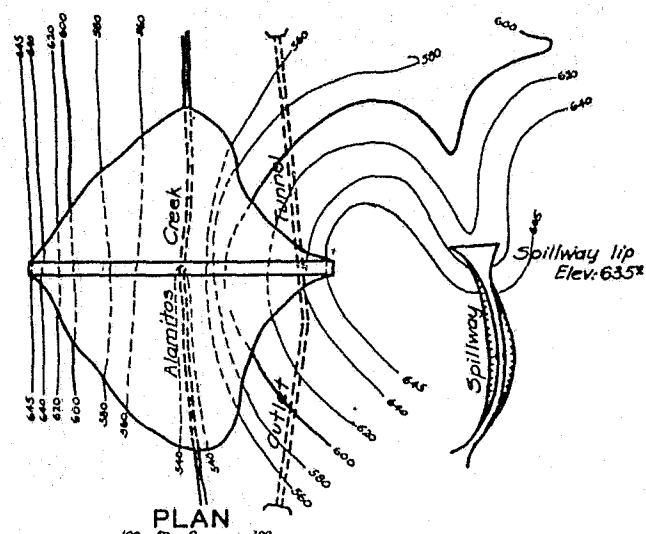

Acres
10
20
30
40
50
60
W.S. Elev. 640
Acre Feet
300
1000
1500
2000
2500
3000
AREA AND CAPACITY CURVES
From Tibbetts and Kiefer Report, Plate 41
SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT
ALMADEN RESERVOIR SITE
SCALE AS SHOWN
DATUM ASSUMED
DATE: AUGUST, 1931.
FRED H TIBBETTS
CIVIL ENGINEER
SAN FRANCISCO, CALIF
FILE NO
1054-A-5
DR
CK. JHW
TR
AP

PLATE 7



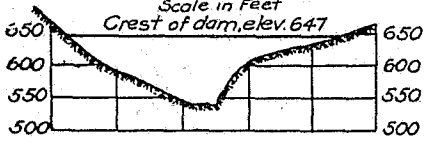
MAXIMUM SECTION

100 50 0 100
Scale in Feet



PLAN

100 50 0 100
Scale in Feet



PROFILE

SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT

ALMADEN DAM SITE

SCALE: AS SHOWN
DATUM: ASSUMED
DATE: AUGUST 1933

FRED. N. TIBBETTS
CIVIL ENGINEER
SAN FRANCISCO, CALIF.

FILE No. 1054-A-6

DR. C.A.S. CK. R.M.J.
TR. L.F.L. APPROVED

PLATE 8

Guadalupe Dam. (Figure 3, Plates 9 and 10).

The Guadalupe dam is located about 1½ miles above the Guadalupe mine. It will back the water up about 1½ miles to the forks at the upper end of the valley. Rock is exposed at both of the abutments. A combination earth and rock fill dam is proposed, but this may be changed to either a masonry or rock fill dam.

For both the Almaden and Guadalupe dams, detailed plans and estimates have been prepared for alternative designs for concrete (Ambursen or multiple arch types) or earth fill dams, and bids should be received on both alternatives.

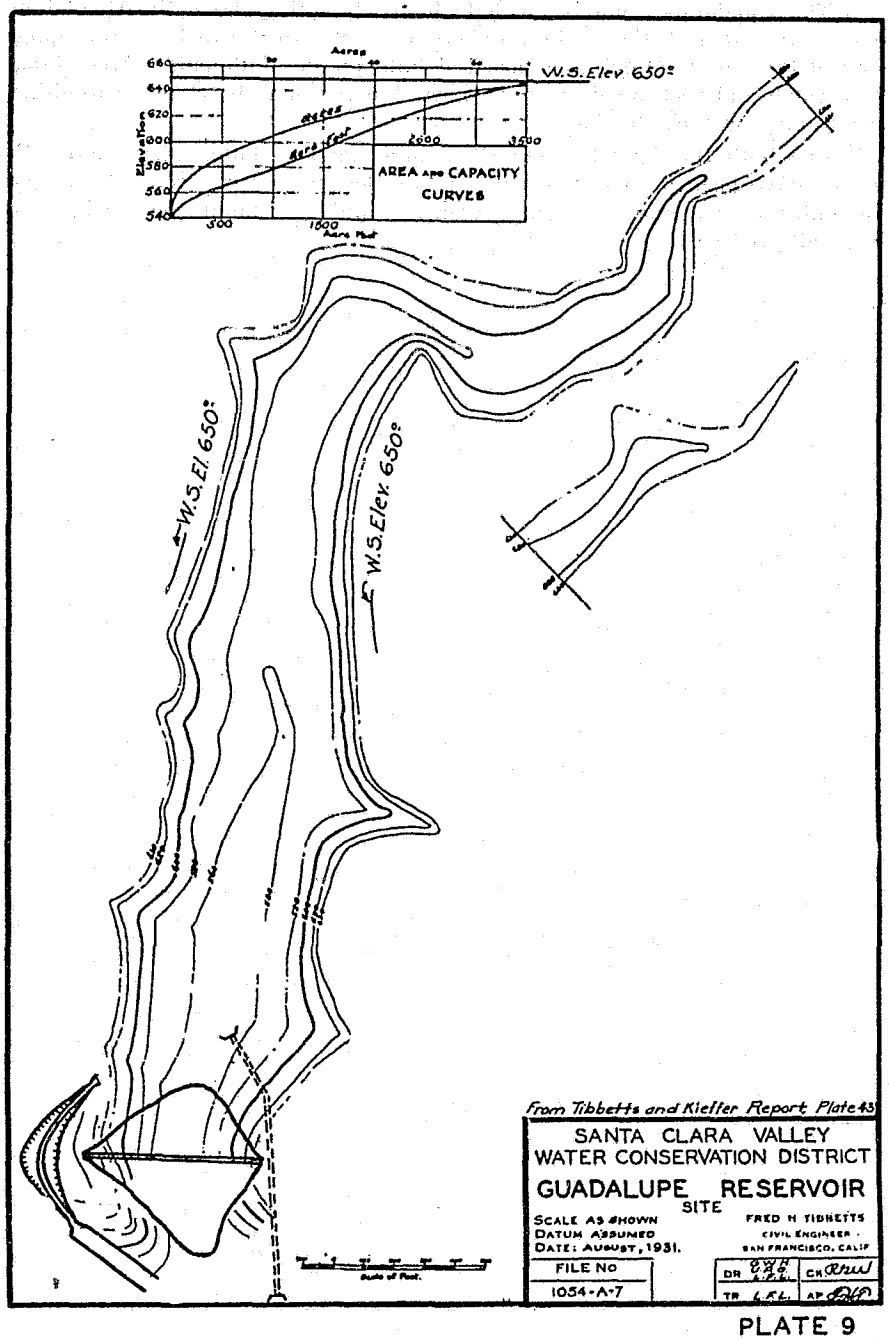
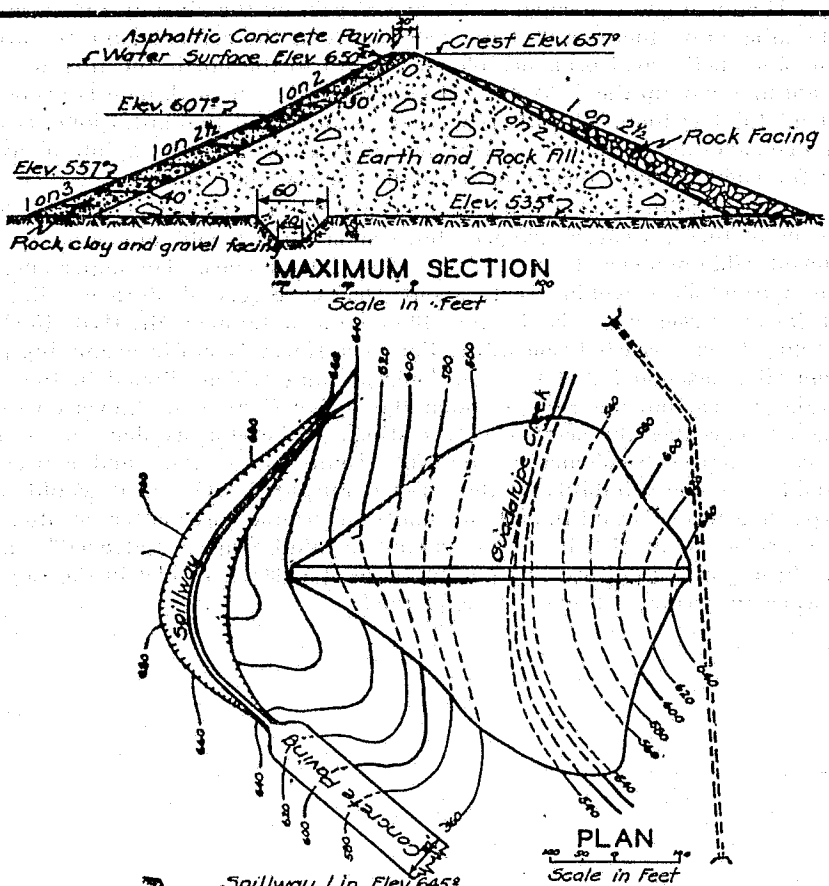

Acres
660
640
620
600
580
560
540
Elevation
W.S. Elev. 650'
2000
3500
AREA and CAPACITY CURVES
300
1800
Acre Feet
W.S. El. 650'
W.S. Elev. 650'
Scale of Feet
From Tibbetts and Kiefer Report Plate 43
SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT
GUADALUPE RESERVOIR SITE
SCALE AS SHOWN
DATUM ASSUMED
DATE: AUGUST, 1931.
FRED H TIBBETTS
CIVIL ENGINEER
SAN FRANCISCO, CALIF
FILE NO
1054-A-7
DR
CK
TR
AP

PLATE 9



SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT

GUADALUPE DAM SITE

SCALE: AS SHOWN
DATUM: ASSUMED
DATE: AUGUST, 1934

FRED. H. TIBBETTS
CIVIL ENGINEER
SAN FRANCISCO, CALIF.

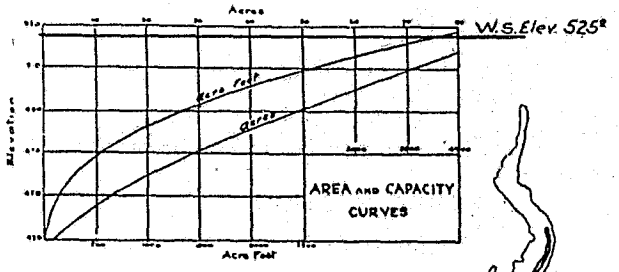
FILE NO	DR. G.W.H. V.S.S. L.F.L.	CK.
1054-A-8	TR. L.F.L.	

PLATE 10

Stevens Creek Dam, (Figure 4, Plates 11 and 12).

This dam site is located on Stevens Creek, on the Murphy ranch, about one mile above the mouth of the canyon. Near the center of the reservoir, the Montebello road branches off up the hill to the north and this and the main highway up the Canyon must be relocated. An earth dam is proposed about 107 feet high. It will create a reservoir about two miles long, covering considerable orchard. A detached spillway will discharge into a ravine at the right of, and considerable distance below, the dam.

Three additional dam sites have been surveyed on Stevens Creek. The lower of these, a short distance above Soda Rock would submerge a very considerable number of fine resorts and summer homes. The upper one, on the Mason place, would create about 2,000 acre feet of storage. Storage of Stevens Creek water is also possible off the watershed. Mr. Hyde Forbes, Geologist, who assisted Consulting Engineer Harry Haehl in examining this dam site, has noted that the San Andreas fault which slipped in the San Francisco earthquake runs through the upper Canyon of Stevens Creek. He also classifies the geological formations at the Murphy dam site as belonging to the "Geologically youthful" Santa Clara series and expresses doubt as to the suitability of the large ("Murphy") site. As it would take expensive test pits and tunnels to finally determine this matter an alternative project to furnish the same amount of additional or "salvaged" water has been worked out involving an increase of 15,000 acre feet in the Coyote storage reservoir as previously explained.





From Tibbetts and Kiefer Report, Plate 51

SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT

STEVENS CR. RESERVOIR SITE

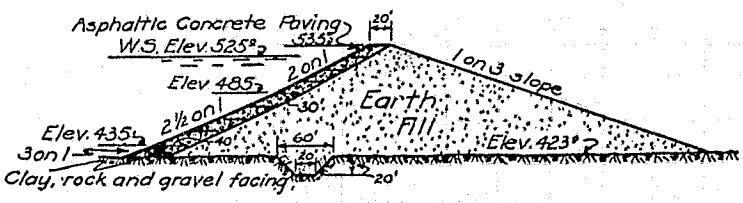
SCALE: AS SHOWN
DATUM: ASSUMED
DATE: AUGUST, 1931.

FRED H. TIBBETTS
CIVIL ENGINEER
SAN FRANCISCO, CALIF

FILE NO. 1054-A-9

DR. E.W.H. CK. H.H.W.
TR. L.F.L. AP.

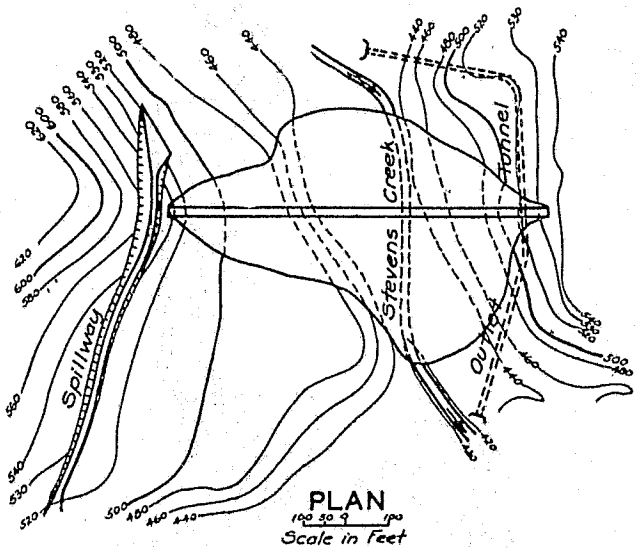
PLATE 11



MAXIMUM SECTION

100 50 0 100

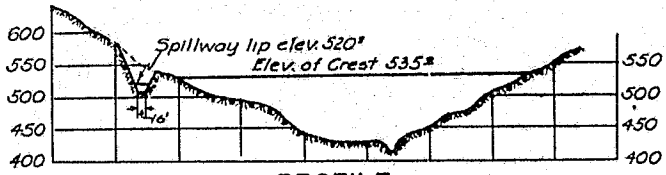
Scale in Feet



PLAN

100 50 0 100

Scale in Feet



PROFILE

SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT

STEVENS CREEK DAM
SITE

SCALE: AS SHOWN
DATUM: ASSUMED
DATE: AUGUST, 1931.

FRED. H. TIBBETTS
CIVIL ENGINEER
SAN FRANCISCO, CALIF.

FILE NO. 1054-A-10

DR. C.H.S. CK. R.W.J.
TR. L.K.L. AR. F.H.T.

PLATE 12

TABLE 7
SUMMARY OF DAMS AND RESERVOIRS

	Coyote	Calero	Calero-Almaden Almaden	Incl. Canal	Guadalupe	Stevens	Totals
Storage capacity..	60,000	9,000	2,500	.....	3,500	4,000	79,000
Area submerged....	900	320	60	.....	80	100	.....
Water surf. elev....	605	480	640	.....	650	525	.....
Type	E&R	E	E&R	.....	E&R	E	.....
Max. height, ft....	212	90	107	.....	122	112	.....
Crest length, ft.....	1,060	670	426	.....	610	840	.....
Volume, cu. yds....	1,891,000	308,000	162,000	.....	303,000	386,000	.....
Spillway cap., sec. ft.....	60,000	2,000	3,000	.....	2,000	5,000	.....
TOTAL COST ..	$1,964,400	$369,500	$213,800	$809,300	$318,600	$448,900	$3,541,200
Cost per ac. ft. of cap.	$32.70	.....	.....	$70.40	$91.00	$112.20	$44.80
Guadalupe Development incl. Calero, Almaden and Guadalupe Reservoirs, Canal, and Guadalupe Percolating Reservoir							
TOTAL COST.....	$1,964,400	.....	.....	$1,193,900	.....	$448,900	$3,607,200
Av. Annual Salvage, ac. ft.....	33,500	.....	.....	8,460	.....	4,350	46,310
Cost per ac. ft. salv.	$59	.....	.....	$141	.....	$103	$78

CHAPTER IV

DISTRIBUTING CANALS

Largest Water Supply Remote From Region of Greatest Depletion

In this project, as in most conservation projects, the region of most abundant natural water supply is not coincident with the region of most acute water shortage. Nearly half of the total water supply available for conservation originates in the Coyote River watershed of 193 square miles, which is 44% of the total area tributary to Santa Clara Valley. This watershed terminates at the upper gorge of the Coyote River, eight miles south of the southern end of the District. Natural percolation from the Coyote stream bed directly supplies only the wells situated in a long narrow area of the district about three miles wide and fifteen miles long, or less than a fourth of the total district area.

The maps accompanying the Division of Water Resources report indicate very clearly that the large areas of most acute water shortage are in the western and particularly northwestern portion of the valley. Of the total area shown on Plate 1 in which in the 15 years, 1915-1930, the drop in the water plane has been more than 50 ft., slightly over two thirds, is west of the State Highway and beyond the influence of direct percolation from the Coyote River bed. The area in which the drop has been more than 100 ft. since 1915 centers near Campbell five or six miles west of the Coyote supply area, and 19½ miles northwest of the upper gorge where the Coyote River emerges from the mountains.

The basic problem of distribution of conserved flood water in the Santa Clara Valley hence becomes largely the problem of shifting the surplus water of the Coyote River diagonally across the Valley, a distance of 20 miles or more to the areas of greatest water shortage.

Coyote Valley Water Requirements.

The riparian doctrine, firmly established in California, gives prior rights to the flow of any stream to the lands bordering the stream. There is also a general feeling, not necessarily founded on a sound legal basis, but nevertheless firmly asserted, that preferential rights to water percolating from stream beds are vested in the valley of that stream. In the decree of the Hayes-Chynoweth vs. Bay Cities Water Co. case, certain prescribed rules were laid down for apportioning water to the Coyote gravels after which water might be diverted for use elsewhere in the Valley. Under the terms of this decision the first 18,800 acre ft. of the Coyote's annual runoff should be released at such a rate as would permit of complete absorption. 6.6% of the balance of the stream flow should be similarly reserved for the Coyote Valley. Under this ruling the Coyote Valley should normally receive about 20,000 acre ft. per annum, and experience has apparently shown that in normal seasons this is sufficient for the replenishment of wells drawing directly from aquifers normally replenished by Coyote stream bed flow.

COYOTE RIVER EXPORTABLE WATER

In years in which the normal Coyote runoff exceeds 20,000 acre ft. it should be possible, without detriment to the Coyote Valley, to export the excess water and transfer it northwesterly to the region of greatest water shortage. In the portion of this region, immediately west of San Jose, a broad, deep depression has been developed in the underground water plane. The natural underground water supply of the Coyote Valley is pulled away toward the west. If this portion could be replenished through its natural underground channels, then water percolating through the Coyote stream bed would better hold up the water plane for the wells in the Coyote Valley.

The Division of Water Resources report estimates the average annual discharge of the Coyote River at Madrone, during the subnormal period of their record (1902-13 and 1916-30), as 56,000 acre ft. Tibbetts & Kieffer estimated the average for the 18 year normal period, 1902 to 1920, as 80,380 acre ft. Even though the last 15 year period has been much subnormal with only three years out of 15 showing more than normal precipitation, yet there have been 7 years during this time in which the measured waste past Edenvale on the Coyote River, which is generally considered the end of important stream bed percolation, has been over 20,000 acre ft. per year. (Division of Water Resources Report P. 36). In all but two of the last fifteen years water has wasted past Edenvale. The average waste in this subnormal period is given in the Division of Water Resources report as 20,000 acre ft., the maximum being 57,000 acre ft. The average, when normal seasons are again resumed, will be materially in excess of these amounts. It is obvious that after supplying the needs of the Coyote Valley there is a large amount of surplus exportable water which can be shifted

to the west side areas of greatest deficiency and if such transfers bring up the water plane on the west side they will check the deep underground draft from the Coyote Valley toward the west. With the resumption of normal seasons there will be an exportable excess from the Coyote Valley averaging 34,000 acre ft. per year. (Tibbetts and Kieffer P. 16). In many seasons there will be much more.

As the fundamental physical basis for water conservation for the Santa Clara Valley Water Conservation District, the excess flood water of the Coyote must be detained in surface storage until it can be transferred by appropriate works into underground storage in the areas of greatest depletion on the west side of the Valley.

GENERAL OUTLINE OF DISTRIBUTION PLAN (PLATE 13)

Old Tibbetts and Kieffer Project.

The Tibbets & Kieffer project of ten years ago was for the conveyance of water in a surface canal starting almost immediately from the Upper Gorge reservoir, to the southern point of the Santa Teresa hills below Almaden, where the canal would be split, a portion of the water proceeding on grade through Campbell and the center of the West Side area and the balance being pumped into a high marginal West Side canal. A small canal was also proposed on the East Side of the Valley with a pumping plant near Alum Rock.

New Plan:—Maximum Coyote River Conveyance.

A basic change in this plan is now recommended, by which diversion from the Coyote would start at the Narrows opposite Edenvale, or about 12 miles farther down the river than formerly proposed.

There are two fundamental reasons for this proposed change. One is the desire to use Coyote River waters, even regulated reservoir releases, to first replenish the gravels of the Coyote Valley to the fullest possible extent before transferring the surplus to the West Side areas. The State Water Resources investigation has confirmed previous determinations that stream bed percolation from the Coyote River is essentially confined to the portion of the river between the Upper Gorge and the Edenvale Narrows. The channel of the Coyote River below the Edenvale Narrows lies on top of extensive impervious clay deposits and hence practically all of the stream flow passing the Edenvale Narrows is unable to leave the stream bed by percolation, but continues on down the river and is wasted into the bay. This being true, if Coyote River waters occupy the natural stream bed through the length of its natural percolative area and are transferred to the west side areas from the Edenvale Narrows, then the only water so transferred is water which would otherwise be wasted into the bay.

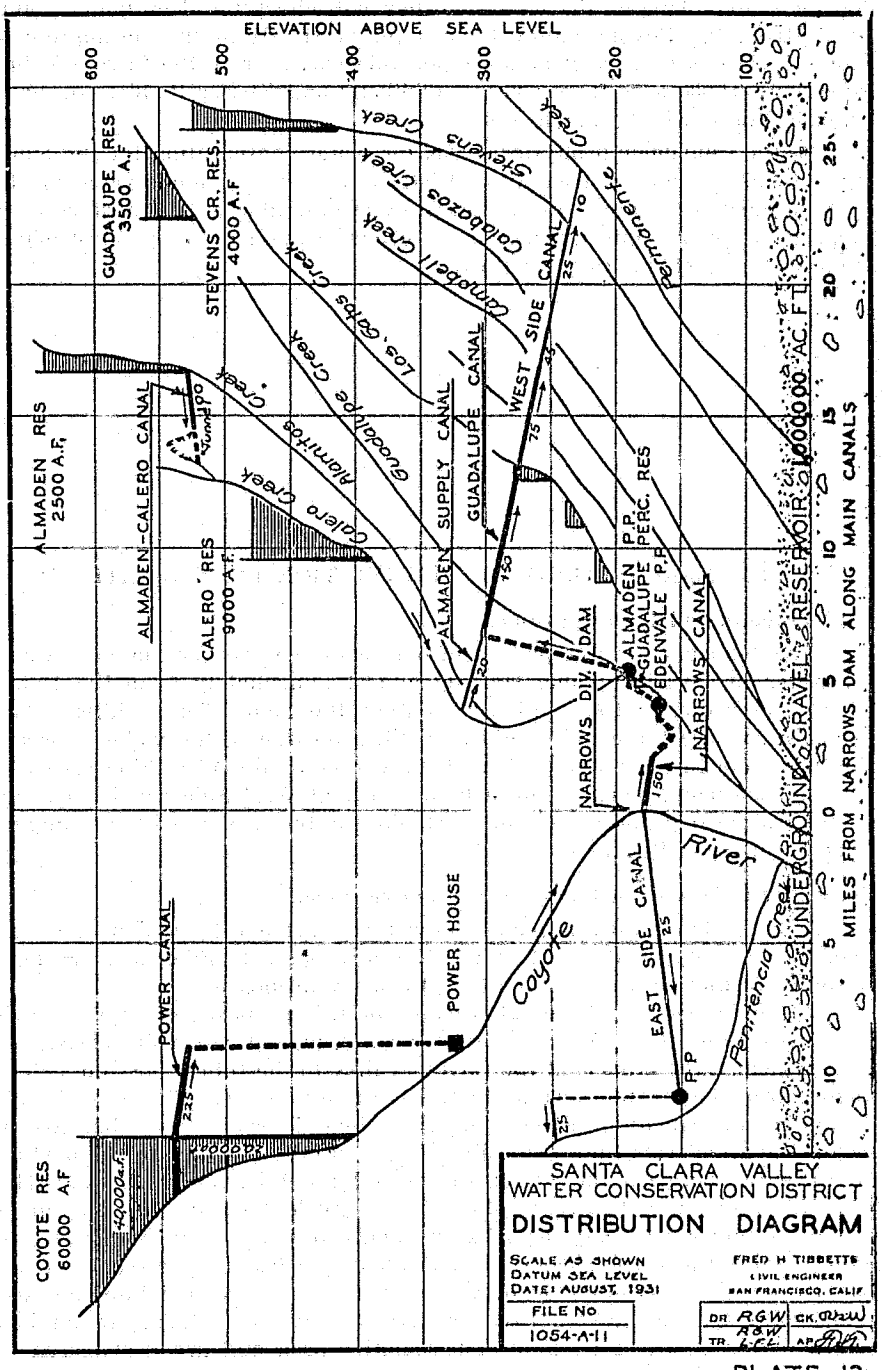

ELEVATION ABOVE SEA LEVEL
600
500
400
300
200
100
GUADALUPE RES 3500 A.F
STEVENS CR. RES. 4000 A.F
ALMADEN RES 2500 A.F
ALMADEN-CALERO CANAL
CALERO RES 9000 A.F
COYOTE RES 60000 A.F
Stevens Creek
Cobberos Creek
Campbell Creek
Los Gatos Creek
Guadalupe Creek
Alamitos Creek
Calero Creek
Permanente Creek
WEST SIDE CANAL
GUADALUPE CANAL
ALMADEN SUPPLY CANAL
ALMADEN P.P.
GUADALUPE P.P.
EDENVALE P.P.
PERC. RES
NARROWS DIV. DAM
NARROWS CANAL
POWER CANAL
POWER HOUSE
EAST SIDE CANAL
Coyote River
Penitencia Creek
P.P.
UNDERGROUND GRAVEL RESERVOIR 1,000,000 AC. FT.
MILES FROM NARROWS DAM ALONG MAIN CANALS
SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT
DISTRIBUTION DIAGRAM
SCALE AS SHOWN
DATUM SEA LEVEL
DATE: AUGUST, 1931
FRED H TIBBETTS
CIVIL ENGINEER
SAN FRANCISCO, CALIF
FILE NO
1054-A-11
DR. RGW
CK. RGW
TR. A.C.C.
AP.

PLATE 13

Power Project.

The second reason for the basic change in distribution is purely technical. Hydro-electric power engineering, especially as it concerns the design and operation of small isolated power plants has made great advances in the last decade. Where topography permits, power plants and short pressure conduits with pumping plants may be substituted for much longer and more expensive gravity conduits. This principle governs the design of the Colorado River aqueduct. It is now proposed to divert from the Coyote Reservoir, at an elevation which will receive about 2/3 of the total storage, into a side hill, concrete lined, power canal about three miles long where a hydro-electric power plant will be constructed with about a 200 ft. head discharging into the Coyote River, and generating about 3,600 horsepower. The Power thus obtained will be sufficient to do practically all of the pumping required for the proposed transfer of water from the Coyote to the West Side areas, and may also even furnish sufficient surplus for the small East Side pumping plant near Alum Rock. The combined cost of power plant and power canal and the Narrows diversion works, pressure pipes, and pumping plants, necessary to deliver water into the West Side canal will be over a half million dollars less than the cost of the gravity canals formerly proposed to accomplish about the same service. The power plant will be entirely seasonal in operation. It will operate only when there is more than 20,000 acre ft. of accumulated storage in the Coyote reservoir. The power generated would be of little value to a power company engaged in general distribution. It has full value, however, for use in pumping the same water which generates the power. The power will be used as generated.

WEST SIDE CANAL SYSTEM

Narrows Diversion to Guadalupe Percolating Reservoir.

A permanent reinforced concrete diversion dam on good foundation material will be constructed at a favorable site near the upper end of the Narrows. The superstructure will be movable so that it can be lowered so as to offer no obstruction to flood waters. When in use for controlled reservoir releases, it will raise the water level about 15 ft. to a water surface elevation of 180, backing the water up in the creek bed about 2 miles and forming the lower Coyote percolating area. The same structure will be used for diversion to the distributing canals on both sides of the river. The Narrows canal will be an open, concrete lined ditch with a capacity of 150 sec. ft. along the northerly base of the Edenvale hills, 2 miles in length to the highway north of the Senter Road. This canal will discharge into a 1½ mile concrete pipe siphon 66 inches in diameter, capacity 150 cu. ft. per sec., maximum head 25 ft., conveying the water across a broad low valley to the Almaden branch of the Southern Pacific R. R. There will then be about one-half mile of open cut paralleling the railroad with a maximum depth at the southerly end of about 16 ft. At this point the Edenvale pumping plant, capacity, 150 sec. ft., 600 installed horsepower,

will pump water against a static head of 23 ft. through a 66 inch reinforced concrete pressure pipe .7 miles long into the Guadalupe percolating reservoir at Downer Ave., which has a flow line elevation of 190.

Guadalupe Canal.

Advantage will be taken of the Guadalupe percolating reservoir to transfer the water beyond the junction of the Guadalupe and Almaden creeks at the Almaden road. At this point will be located the Almaden pumping plant, the largest pumping plant proposed with about 3,000 installed horsepower. This plant will pump against a static head of about 113 ft. into the Almaden pressure pipe 1½ miles in length and 66 inches in diameter. The lower portion of this pipe will be steel and the upper portion concrete. To shorten the length of the maximum head portion of the pipe as much as possible, it will be laid along the base of a small group of hills in this vicinity and will terminate at a water surface elevation of 303 on a steep hillside about ¾ mile east of the Guadalupe creek. The Guadalupe canal, six miles in length, capacity 150 sec. ft., fall 3 ft. to the mile, water surface elevation 303 to 285, will then convey the water westerly to the upper Los Gatos percolating reservoir near Vasona Junction. The canal will cross Guadalupe creek in a high metal flume and continue at the foot of the hill slope for three miles to the head of Ware Avenue. The remaining three miles will be through orchard land, crossing the San Jose and Los Gatos road at the foot of National Avenue. The canal will feed directly into the Los Gatos percolating reservoir.

West Side Canal.

The West Side canal will continue northwesterly with a fall of three ft. per mile for 10 miles to Stevens Creek at the district boundary line at the railroad and highway between Monte Vista and Loyola. The first 4½ miles to Campbell creek will have a capacity of 75 sec. ft. The next mile and a half to Calabazas creek will have a capacity of 45 sec. ft. The remaining four miles to Stevens Creek will have a capacity of 25 sec. ft. Crossings of the San Tomas Aquinas, Campbell, Calabazas and Stevens Creeks will be in metal flumes or reinforced concrete pipe siphons with arrangements for discharging water at each stream crossing, to supply stream bed percolation.

A diversion and percolating dam will be constructed in Stevens Creek near the Homestead road and this will intercept reservoir releases from the Stevens Creek reservoir as well as the West Side canal. From Stevens Creek to Permanente Creek at Loyola, a 2 mile ditch and concrete pipe line will be constructed with a capacity of 10 sec. ft. to supply water for stream bed percolation in the Permanente Creek, the most northerly of the stream beds in the District.

East Side Canal.

A small marginal East Side canal is essential to supply the area of acute water shortage east of San Jose and generally above the influence of direct percolation from the Coyote River bed. The East Side canal will utilize the Narrows diversion dam diverting from the Coyote, at water surface elevation of 180, and will proceed northerly along the easterly margin of the valley generally outside of the district boundary line in order to follow a grade contour, about 11 miles to Reed Avenue where the water

will be lifted by a pumping plant 100 ft. from elevation 153 to 253 and pumped through a 30 inch pipe line of steel and concrete .5 miles long. This pumping plant will have an installed horse power of 400. The canal will then continue about parallel to and a short distance above Toyon Avenue and will terminate at the intersection of Toyon Avenue and Penitencia Creek, a point on the district boundary line just above what are believed to be very receptive gravel percolating areas in the bed of Penitencia Creek, and immediately north on Piedmont Road. This entire canal will be about 12.6 miles in length, will have a fall of 3 ft. per mile and will be a concrete lined open ditch of 25 sec. ft. capacity.

CONDUIT SUMMARY

The entire distribution system with conduit capacities and grades is shown in the accompanying Table 8.

TABLE 8
SUMMARY OF CONDUITS

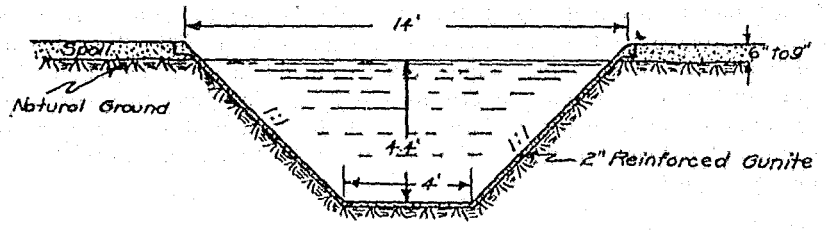
CANAL	Capacity sec. ft.	Length miles	Bottom Width ft.	Top Width ft.	Depth ft.	Delivery Elevation Outlet End
Narrows Canal	150	2.0	4	12.8	4.4	174
Edenvale Siphon	150	1.5	66 inch pipe			168
Edenvale Canal	150	0.5	4	12.8	4.4	167
Edenvale Pumping Plant	150	—	600 horse power			
Edenvale Pressure Main	150	0.7	66 inch pipe			190
Guadalupe Perc. Res.	.....	0.6				
Almaden Pumping Plant	150	—	2800 horse power			
Almaden Pressure Pipe	150	1.5	66 inch pipe			303
Guadalupe Canal	150	6.0	4	12.8	4.4	285
Upper Los Gatos Perc. Res.						
WEST SIDE CANAL						
Los Gatos to Campbell Creek	75	4.5	3	10.0	3.5	271
Campbell Creek to Calabazas	45	1.5	3	8.4	2.7	267
Calabazas to Stevens Creek	25	4.0	3	7.0	2.0	255
Stevens Creek to Permanente Cr.	10	2.0	2	5.0	1.5	249
TOTAL WEST SIDE SYSTEM		24.8				
East Side Canal to Reed Ave.	25	11.0	3	7.0	2.0	153
East Side Pumping Plant	25	—	400 horse power			
East Side Pressure Conduits	25	0.5	30 inch pipe			253
East Side Canal to Penitencia Creek	25	1.6	3	7.0	2.0	242
TOTAL EAST SIDE CANAL		13.1				
GRAND TOTAL BOTH DISTRIBUTING CANALS		37.9				
Almaden Supply Canal	20	8.5	3	6.6	1.8	303
		46.4				
Power Canal	225	2.8	5	15.0	5.0	532
		49.2				

CANAL CONSTRUCTION

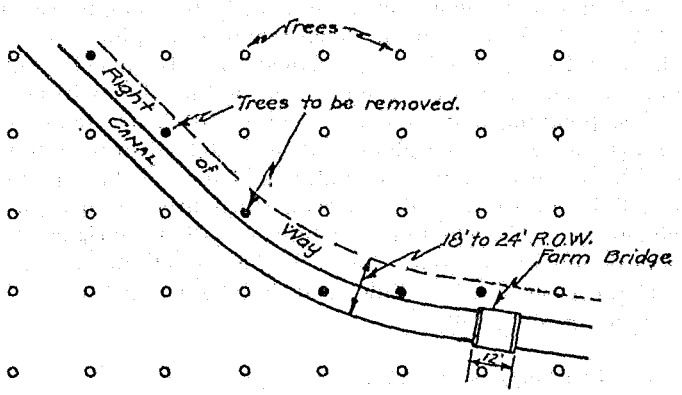
Open, Cement Lined, Ditches (Plate 14).

Of the total length of 46.4 miles of distributing system exclusive of the power canal, 42.2 miles or 91% will be open concrete lined ditches. Most

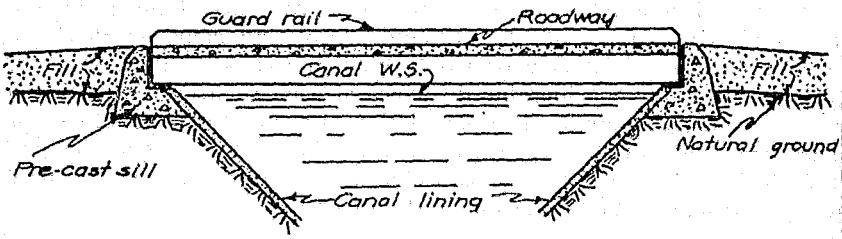
of this mileage passes through very highly developed orchards with frequent road crossings. The type of construction should be such as to require a minimum width of right-of-way and minimum disturbance to existing improvements. Canals will be constructed with bottom widths from 2 ft. to 5 ft. with water depths from 1.5 to 5.0 ft. and with top widths from 3 ft. to 15 ft., side slopes one on one. Reinforced gunite or concrete plaster lining about 2 inches thick will be used. This type of construction enables considerable variation from grade contour location so that wherever possible the ditches will be built between rows of trees or along property lines or roads so as to minimize damage to improvements. Concrete lining facilitates deviation from rigid contour location as it enables high velocity without destructive erosion and enables water to be carried above the ground surface without danger from seepage or burrowing animals in canal banks. It is proposed in all cases to extend the concrete lining six inches above the maximum water operating surface and above this point to distribute excavated material, level and graded out into the orchards so as not to injure the adjacent trees. This method of construction will enable many of the ditches to be built between 20 ft. rows of trees without sacrificing the trees. If the excavated material is distributed as proposed, there will be no loss to the appearance of the orchards. Rights-of-way should be wide enough for a minimum width roadway, say 10 ft., paralleling the ditch banks, for construction, inspection, operation and maintenance purposes. If this method of construction is followed, it is believed that rights-of-way need not be acquired in general for a top width more than 10 to 12 ft. greater than the net top width of the ditches.



MAXIMUM CANAL CROSS SECTION

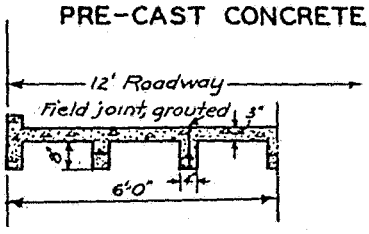


TYPICAL CANAL LOCATION THRU ORCHARD



LONGITUDINAL SECTION

PRE-CAST CONCRETE FARM BRIDGE



HALF CROSS SECTION

SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT
TYPICAL CANAL SECTION
AND FARM BRIDGE

SCALE:
DATUM:
DATE AUGUST 1931

FRED. H. TIBBETTS
CIVIL ENGINEER
SAN FRANCISCO, CALIF.

FILE NO. 1054-A-12

DR. R.G.W. CK. R.H.W.
TR. L.F.L. AP.

PLATE 14

Pipes and Siphons.

The pressure pipes and siphons between the Narrows canal and the head of the Guadalupe Canal aggregating 3.7 miles in length, will be reinforced concrete pipes except for the lower highhead portion of the Almaden pipe, which will be steel. These pipes will be buried to minimize right-of-way costs and to protect from temperature changes. The pipe lines cost two to four times as much per lineal ft. as concrete lined open ditches, hence every advantage has been taken of variations in topography to minimize the total length of pipe lines.

Pumping Plants.

As the pumping plants are approached, the conduits run into deep cuts about 15 ft. deep in order to shorten expensive pipe lines. The pumping plants will be equipped with vertical, direct-connected, electric pumps. The pumps should always be submerged so that they will not require priming. The pumping plant superstructures will hence tend to be low, even below ground level. The plants will be designed to be automatic in operation with the idea of having one attendant for the three plants. The buildings will be of reinforced concrete, substantial in design, fireproof and burglar-proof. The pumping machinery will be designed for the highest efficiency and for automatic and reliable operation. The pumping plants, at least those on the West Side, will directly use power as generated from the Coyote power plant.

Drainage Crossings (Plate 15).

The conduits will pass around the margin of the Valley close to the district boundary line, near the edge of the foothills and will cross numerous natural creek channels or waterways. At some of the main creeks the canal will cross at grade, utilizing percolating dams or check dams for this purpose. Water in transit through the canals will then back up the creek beds for considerable distances at each such crossing, thus continuously supplying stream bed percolation at such points. At other points canal crossings will be effected by concrete pipe siphons passing below the creek beds or by metal flumes with steel and concrete supports of permanent construction. See Plate 15.

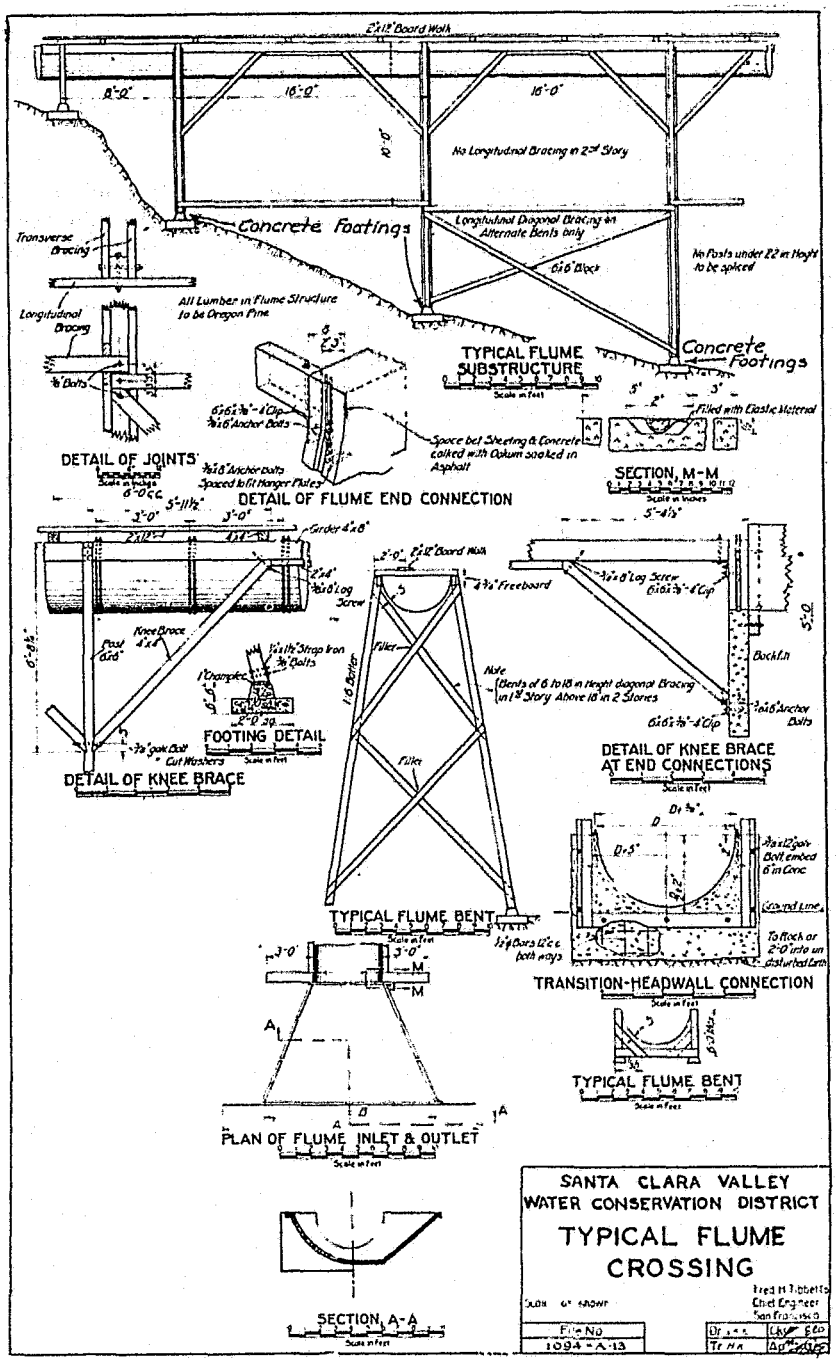

2"x12" Board Walk
8'-0"
16'-0"
16'-0"
10'-0"
No Longitudinal Bracing in 2nd Story
Concrete Footings
Longitudinal Diagonal Bracing in Alternate Bents only
6"x6" Block
No Posts under 22' in Height to be spliced
Transverse Bracing
Longitudinal Bracing
All Lumber in Flume Structure to be Oregon Pine
Concrete Footings
TYPICAL FLUME SUBSTRUCTURE
Scale in Feet
DETAIL OF JOINTS
Scale in Feet
DETAIL OF FLUME END CONNECTION
Space bet Sheeting & Concrete caulked with Oakum soaked in Asphalt
SECTION M-M
Scale in Inches
Filled with Elastic Material
Girder 4"x8"
Knee Brace 4"x4"
Post 6"x8"
FOOTING DETAIL
Scale in Feet
DETAIL OF KNEE BRACE
Cut Washers
Filler
Note
Ubents of 6 to 18 in Height diagonal Bracing in 1st Story Above 18' in 2 Stories
Backfill
DETAIL OF KNEE BRACE AT END CONNECTIONS
Scale in Feet
TYPICAL FLUME BENT
Scale in Feet
TRANSITION-HEADWALL CONNECTION
Scale in Feet
Ground Line
To Rock or 2'-0" into undisturbed Earth
TYPICAL FLUME BENT
Scale in Feet
PLAN OF FLUME INLET & OUTLET
Scale in Feet
SECTION A-A
Scale in Feet
SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT
TYPICAL FLUME
CROSSING
Fred H. Tibbetts
Chief Engineer
San Francisco
File No
1094-A-13

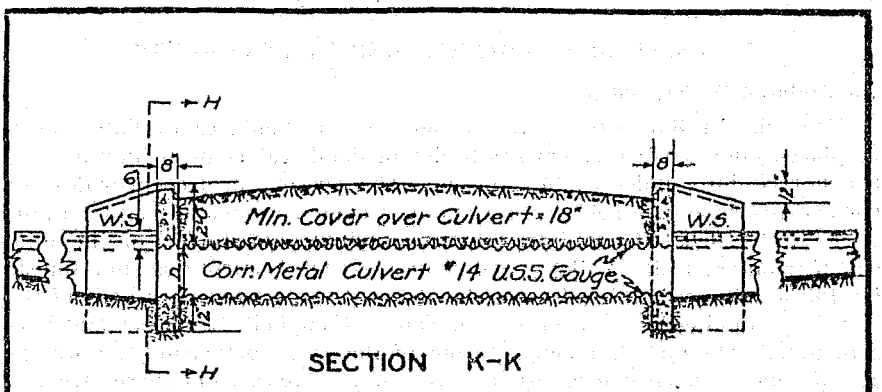
PLATE 15

Road Crossings (Plate 16).

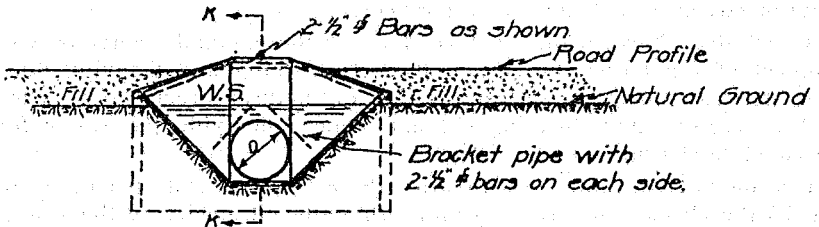
The canals will cross numerous paved main highways and other fixed roadways. Reinforced concrete pipe inverted siphons with concrete headwalls will be used for all such crossings. Tapering transition sections from canals to pipes will be provided to save loss of head on the canals.

Farm Bridges (Plate 14).

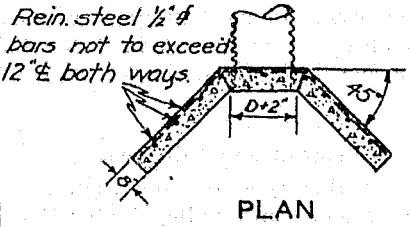
The canals will cross many different, separate property holdings. For all such separate holdings and for at least every half mile of canal, secondary farm bridges will be provided so as to give the owners, whose properties are cut in two by the ditch lines, free access to the severed portions. There will be so many of these crossings, about 200 in all, that a special design has been prepared for a pre-cast reinforced concrete farm bridge cast in three sections each 4 ft. in width, which can be moved, if necessary, from one point to another. These bridges set up upon the banks of the concrete lined canals will provide permanent road crossings 12 ft. in width. If the property owners wish, at some future date, these bridges can be moved without great expense. See Plate 14.



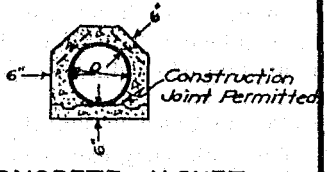
SECTION K-K



SECTION H-H



PLAN
Inlet and Outlet Alike



CONCRETE JACKET
Use when directed by Engineer.

0 1 2 3 4
Scale in Feet

SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT
TYPICAL HIGHWAY CROSSING

SCALE: AS SHOWN
DATUM:
DATE: AUGUST 1921

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FILE NO.
1054-A-14

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PLATE 18

CHAPTER V

WATERSHED AND STREAM BED IMPROVEMENTS

Unregulated Watersheds.

The chief reliance for water conservation in Santa Clara Valley must be placed upon surface reservoirs to detain flood waters until they may be transferred into underground storage. The present project provides for surface reservoir control on the Coyote, Almaden, Guadalupe and Stevens Creek watersheds. These watersheds contribute about 59% of the total runoff tributary to the Valley. Economic reservoir control does not appear feasible for the remaining 41% of the runoff. The seven watersheds of the Berryessa, Penitencia, Los Gatos, San Tomas, Campbell, Calabazas and Permanente Creeks include about 36% out of the 41% comprising this unregulated runoff. Such conservation of the flood waters from these streams, as can be accomplished, must be dependent upon other and less effective means. Two methods will be proposed; spreading or percolating dams and check dams. "Spreading dams" and "percolating dams" are low structures built in the stream beds on the floor of the valley, with the object of increasing stream bed percolation. They have no effect upon the amount or rate of stream flow from the watersheds.

"Check dams" are small structures built in the mountain canyons with the object of regulating the stream flow, restraining and delaying flood waves, increasing bank storage, and prolonging natural stream flow. They are also effective in restraining silt and hence clarifying the water for more effective stream bed percolation.

It is mutually advantageous to work these two types of structures together as the check dams by restraining the silt and clarifying the water, make the spreading or percolating dams more effective. These two types of construction will be recommended for use together for the seven unregulated watersheds listed on the foregoing page. In most of these creeks, stream bed percolation rates have been observed, as shown in Table 10, which indicates that all of the natural stream beds are quite receptive to this method of treatment.

Design and Construction of Check Dams (Olmstead and Gillelen).

The following excellent description of this type of construction is taken from a "Report on Check Dams for Santa Clara Valley Water Conservation District, June, 1930," by Olmstead and Gillelen, Civil Engineers of Los Angeles:

> "The use of small inexpensive retarding structures or check dams to regulate the flood flows originating in the upper reaches of mountain watersheds and to reduce the erosive action of waters traveling at high velocities has been practiced since ancient times and by many different races. The terraced hillsides of South America, China and other countries are examples of extensive check dams which were constructed primarily to create a tillable soil and prevent erosion."
>
> "THE CHECK DAM
>
> In general, a check dam is any cross structure erected, in the stream channel. These dams may be of loose rock, rock and wire, logs, lumber, faggots, cement or any combination of these materials. The structures should be low in order that the failure of one may not menace the entire lowerlying system with a rush of stored water. Two

to six feet is the accepted height. It being considered cheaper and better to build two low dams in a given reach than one high one.

Faggot Barrages: In small feeders near the crest it is frequently impossible to secure rock enough to build the dams and the locations are too inaccessible to permit bringing in such material cheaply. In such cases, barrages of wirebound faggots have proven their worth. Brush is cut from trees and shrubs, bound into rolls and fashioned into a low retarding structure. This type is temporary only and must, of course, be replaced. It is well to have this type in the upper tributaries as a constant reminder that annual inspection of check dam system is essential. These barrages are extremely cheap, very efficient and justify their construction.

Loose Rock Dams: The loose rock or boulder check dam is the most popular and commonly built retarding structure. Material is gathered in the streamway or upon the overlying hillsides and the structure fashioned in places most favorable to its permanence. Bed rock need not be considered in this type of construction if a gravity section is employed, if the spillway crest and apron are carefully built, and if the abutments are well raised and arched to some convenient natural obstruction. Heavy units should be used on the dam crest and if they are unavailable, the mass should be crowned by a log inset into both banks, or by an anchored rock wire "sausage".

Rock Wire Sausages: The "sausage" forms one of the most permanent and desirale of retarding structures, and has the advantage of being indicated where large rock is lacking. Regulation galvanized hog wire is used, rock is laid up thereon and the wire rolled over and laced.

Sausages are cheap to construct and are indicated in lower streamways where the larger flows are to be handled. To insure the stability of the loose rock dams, it is frequently desirable to cap the structure with a small wire-bound sausage.

Log Dams: Little need be said of this type. Log dams indicated where timber is very plentiful, and rock scarce. They are not permanent, are more costly per foot of height and length than the rock structures, but make splendid check dams easily anchored to the banks. They are recommended when the channel is low and flat, but, of course, must be replaced after a few years. Many log dams that are now fifteen years old are still in fair condition.

Concrete Check Dams: Concrete structures are the most expensive and likewise the most permanent. Their use is indicated where either canyon sides or bottom are of rock, where natural materials other than sand and gravel are scarce or where gravity sections are to be built in the wide lower washes. In no case should the structure be made impervious. Retardation is the primary consideration, not storage. If set on bed rock, ample drains should be left through the base to permit normal percolation from gravel deposits that will accrue to the bay behind the dam.

Lumber Check Dams: Where native materials are scarce, where a roadway traverses the canyon, and where alders, maples and cottonwood trees grow along a narrow channel, the redwood check dam is indicated. These structures should be low with a depressed spillway, well braced to convenient trees and securely anchored to the banks. This type can be built economically, operate efficiently, but has the disadvantage of being shorter lived than the rock structure. Where cheap redwood is available the building of many such structures is advised.

Combination Check Dams: All the materials named above may be used in combination. Loose rock dams may be constructed on a cemented apron with a sausage top. Rough masonry walls may be laid across the streamway, just enough mortar being used to bind the units. Loose rock dams can be built upon longitudinal rockwire base. Log spillways may be used on loose rock structures. Log, sausage or lumber wingwalls may be built to protect loose rock dam abutments. Dozens of such combinations must be used if full advantage is taken of natural materials and unit costs kept at a minimum."

Unit Costs.

Olmstead and Gillelen estimated that works of this type on the west side watersheds would cost from about $2,000.00 per square mile to about $4,000.00 per square mile. The district has already constructed 663 such dams on the Calabazas creek, 445 on Stevens Creek, and 535 in Jack's Gulch, a tributary to Almaden Creek, and is now engaged in the construction of about 250 more on a tributary of Almaden Creek about opposite the new Almaden station. The total cost of the structures in Jack's Gulch has been about $4.00 per dam, or about $2,000 per square mile. These have been very well designed and placed. The construction is also excellent and economical. A number of these dams recently constructed or under construction were inspected by the writer in July, 1931. See Figures 5 and 6.

Limitations of Check Dams.

Check dam construction in the mountains should in the future be mainly confined to such watersheds as are not susceptible to treatment by surface reservoirs. The bulk of the wasted water which can be conserved or salvaged, generally occurs during short heavy floods. The check dams now being built by the District are of such a size that it will require about 200 dams to store an acre foot of water and about the same number to submegre an acre of percolating area.

A report on check dams to the Los Angeles County Flood District by E. C. Eaton, Chief Engineer, and Frank Gillelen, Consulting Engineer, dated May 22, 1931, states on Page 17:

> "It is evident from the above costs that in locations where permeable spreading areas exist in the mouths of the canyons, the recharge of underground basins may be accomplished at a small per cent of the cost of providing the increased percolating area by widening of stream beds by means of check dams."

This same report states on Page 9:

> "When check dams have stored and retarded debris to their full capacity they cannot hold any more, and additional debris must be finally carried down stream. A single fairly large storm will fill the storage, so the effectiveness in debris retention is limited to one or two years."



FIG. 5. ROCK CHECK DAM, UPSTREAM SIDE.



FIG. 6. ROCK CHECK DAM. DOWNSTREAM SIDE.

It is evident that in Santa Clara Valley where spreading grounds, debris basins, or storage reservoirs may be economically constructed at foothill sites or on the valley floor, then for a given amount of storage or of percolating area the mountain check dams are more expensive. There are many locations, however, where check dams constitute the only feasible method of water conservation. The writer is here stressing in particular the advantage of mountain check dams for such situations, when used in conjunction with spreading dams and percolating dams on the same streams as they pass through the valley floor below. Estimates in this report are based upon small rock check dams of the type shown in Figures 5 and 6. These seem to be so well designed, located and constructed that the writer can suggest no improvement.

SUMMARY-CHECK DAM DEVELOPMENTS

TABLE 9

SUMMARY OF CHECK DAMS

STREAM	Watershed Area Sq. Mile	Average Runoff Ac. Ft.	Proposed Mountain Check Dams Area Controlled Sq. Mile	Cost Per Sq. Mile	Total Cost $
Berryessa	4.65	1,450	2	3,000	6,000
Penitencia	23.35	9,920	15	3,000	45,000
Los Gatos	43.50	42,330	10	2,000	20,000
San Tomas	5.09	2,100	3	3,000	9,000
Campbell	11.48	11,880	6	2,000	12,000
Calabazas	3.53	1,650	2	4,000	8,000
Permanente	7.99	2,785	7	3,000	21,000
	99.59	72,115	45	.....	$121,000
Valley Totals	440.57	202,535			
%	22.5	35.6			

Percolating Dams.

This term will be applied to permanent structures generally of concrete placed in stream beds to back the water up for considerable distances and submerge portions of the stream beds. Structures of this sort are generally indicated where the creek beds tend to be narrow and of uniform cross section. Well designed and constructed structures of this sort have already been built by the District on the Los Gatos, Campbell, Stevens and Calabazas Creeks.

VALLEY STREAM BED IMPROVEMENTS

Two types of dams, "spreading" dams and "percolating" dams are proposed for stream bed treatment, particularly on streams uncontrollable by surface storage, but treated in part with check dams in the mountains. The object of both these types of structures is to increase the normal rate of stream bed percolation by increasing the area submerged by the stream under natural conditions. Expenditures on works of this sort are not so desirable where effective surface storage sites enable reservoir releases controlled down to such amounts as can be wholly absorbed by natural stream bed percolation.



FIG. 9. CAMPBELL CREEK AT HERMANN AVE.
(Cobble and Gravel Bank)

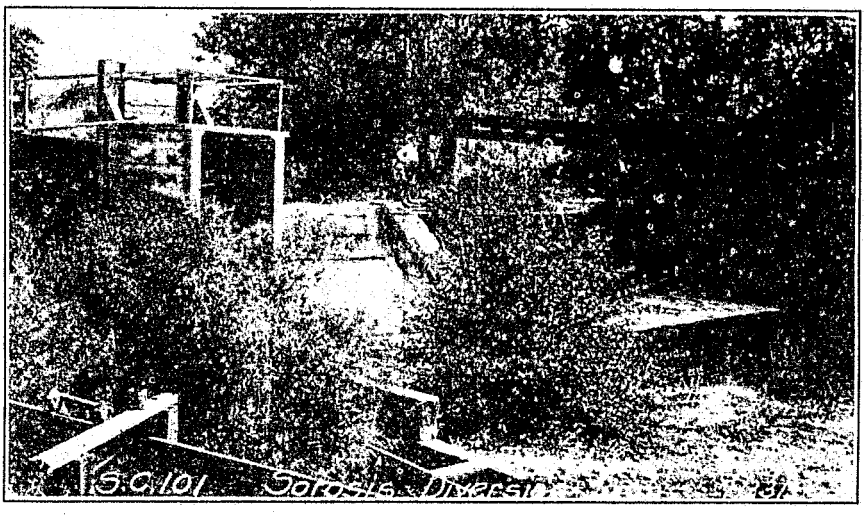


FIG. 10. SOROSIS DAM ON CAMPBELL CREEK.

Spreading Dams.

This term will be used to designate small structures one to three feet in height, constructed across the stream beds at irregular intervals and locations with the object, not of impounding, checking or stilling the moving waters of the stream, but rather of spreading them out, while still moving, over wider areas, thus artificially increasing the stream bed areas submerged under natural conditions. As stream bed percolation normally varies with the area submerged, the effect of these structures will vary with the additions which they make to submerged stream bed areas. They will be ineffective at low stages where the stream flow is all absorbed under natural conditions and will also be ineffective at high stages when the stream bed is all submerged under natural conditions. The normal type of construction will be that described by Olmstead and Gillelen as "rock wire sausages".

Construction work of this sort has already been successfully installed, particularly, in the Coyote and Guadalupe stream beds; Figs. 7 and 8. This work has been well designed, located and constructed and further structures of the same design are recommended on the watersheds on which surface reservoirs are not proposed. Structures herein recommended for further developments of this sort will be of the same general type, except that the larger ones will have movable superstructures which can be quickly raised to permit flood flow to pass unobstructed. This type of construction will not raise the water at flood stages. During high or pro-



FIG. 7. COYOTE SPREADING "SAUSAGE" DAM.

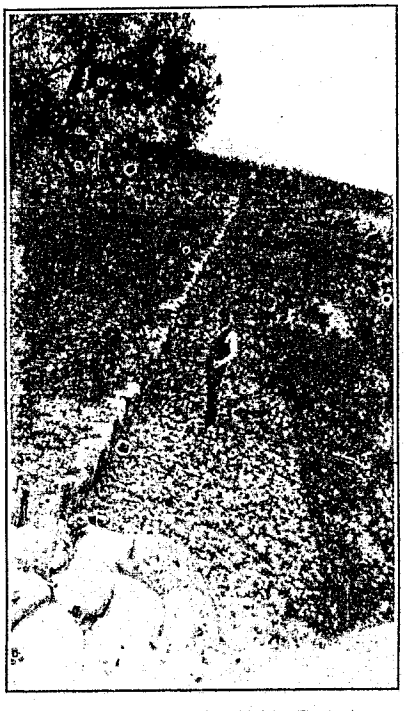


FIG. 8. APRON AND ABUTMENTS OF "SAUSAGE" DAM.

longed floods or during the first floods of the season when the water is very muddy, they will enable flood flows to be passed through the structures without obstruction so that there will be no tendency to silt up the percolating areas. The unobstructed passage through such structures of prolonged floods will have the beneficial effect of flushing out the reservoir floors and restoring the normal percolating rates, if these become reduced by silt deposits.

Steel superstructures will generally take the form of radial gates, (See Plate 17), which can be built in units for holding up the water five or ten feet above the permanent concrete substructure sills. For estimating purposes designs are based upon units 25 ft. in length. A five foot gate of this width will discharge about 1,000 sec. ft. and a ten foot gate, 3,000 sec. ft. This same type of gate will probably be used for all reservoir spillways. Gates will be designed for automatic float control and automatic motor operation. They can be very quickly and easily drawn up well above the water surface so that they will offer no obstruction to water or floating drift. They will automatically fully open, at flood stages.

The dams of this type already constructed by the District are so well built that it is likely that the areas of their percolating ponds can be readily increased by the addition of steel superstructures of this type.

INDIVIDUAL STREAM TREATMENT

The following outline of proposed improvements on important stream beds is intended as a basis for estimates of cost and water salvage. The check dams in the mountains will be in the nature of preliminary treatment to partially clarify the streams during flood times and to prolong their normal run-off period. The proposed construction in the valley sections of these stream beds is somewhat tentative and should be considered subject to extensive change as more detailed information is obtained. Only a portion of the work on any stream should be done the first season. The effects of such partial treatment should be accurately measured as a guide to further regulatory work in succeeding seasons.

Penitencia Creek.

This is much the largest of the East Side streams with a watershed area of over 23 square miles, the eastern portion of which is at a considerable elevation. A careful examination of the creek bed and a study of the ground water contours as shown by the State Water Resources investigation map indicates that the portion of this stream bed receptive to augmentation of stream bed percolation is largely confined to about a mile in length between Toyon Avenue and the White Road. This has fixed the location of the East Side conduit so that it can deliver reservoir releases as high on Penitencia creek as Toyon Avenue. On the right, or northerly bank of the creek at this point, there are extensive areas of very loose,

coarse, gravel and cobbles and there is a large old well at the bottom of which are tunnels of considerable length through this coarse formation. About five acres of this porous cobble ground should be purchased and used for supplementary percolating area, together with the old well and tunnels. The fall in the creek from Toyon Avenue to White Road is about fifty feet. It is proposed in this stretch of creek to construct five new "sausage" spreading dams of gravel, wire netting and steel pipes. It is estimated that the average length of these dams will be 80 ft., permitting them to be run up on the banks to prevent them from being washed out at the sides during high floods. These dams will back the water up a maximum of two feet over an average width of fifty feet and length of 200 feet. The five will create an additional percolating area of about one acre at a cost of about $2,000. It is estimated that this area will have as high an absorption rate as 6 ac. ft. per day. The District should also negotiate for the right to reconstruct some of the existing dams to create additional percolating areas. The total additional absorption thus obtainable for the Penitencia creek might be estimated as follows:

TABLE 10

PENITENCIA CREEK IMPROVEMENTS

New Sausage Spreading Dams	3 sec. ft.
5 acres gravel percolating area opposite end of Toyon Ave.	10 sec. ft.
Old well and tunnels	3 sec. ft.
TOTAL	16 sec. ft.

or, 32 ac. ft. per day.

If 5 sec. ft. be estimated as the natural absorption rate of the creek, then the addition of 16 sec. ft. of absorption capacity, as described, would bring the total absorption capacity of the creek nearly up to the 25 sec. ft. capacity of the proposed East Side distribution canal.

Coyote.

Further improvement of the Coyote river bed is not now recommended because it is proposed to pass all reservoir releases from the large Coyote River storage reservoir down as far as the Narrows. With the Coyote River flow thus artificially prolonged in normal seasons so that there will be a substantial flow for five or six months of each year, there should be ample stream bed percolation from the Coyote.

Guadalupe.

Although the Guadalupe and especially its Almaden branch is well controlled with surface detention reservoirs, the reservoirs, especially on the Almaden, are at such elevations that it will generally be economical to transfer their water supply to the westward substituting Coyote reservoir releases therefor. At the junction of the Guadalupe and Almaden creeks near Downer Avenue there is an especially good wide percolating stream bed area which has already been partially developed by the district by spreading dams. Further spreading dam treatment of the Guadalupe is not recommended because of the extensive reservoir control proposed in the three reservoirs and because of the large percolating reservoir proposed at the junction of Almaden and Guadalupe creeks. Just below Downer Avenue a percolating dam is proposed; see Plate 17 which is typical also

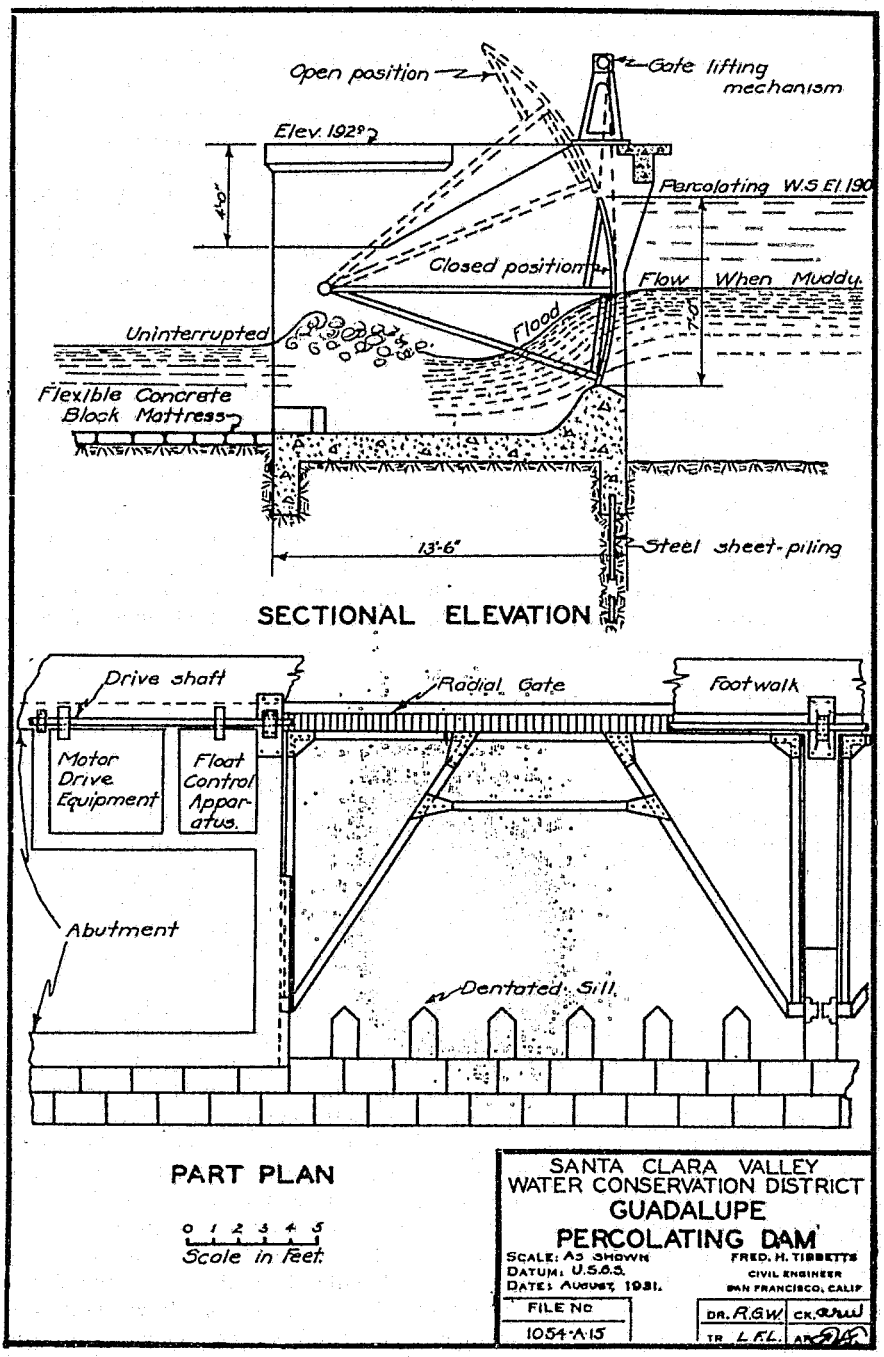

Open position
Gate lifting mechanism
Elev. 192.9
4'-0"
Percolating W.S El 190
Closed position
Flow When Muddy
Uninterrupted
Flood
Flexible Concrete Block Mattress
13'-6"
Steel sheet-piling
SECTIONAL ELEVATION
Drive shaft
Radial Gate
Footwalk
Motor Drive Equipment
Float Control Apparatus.
Abutment
Dentated Sill
PART PLAN
0 1 2 3 4 5
Scale in Feet
SANTA CLARA VALLEY
WATER CONSERVATION DISTRICT
GUADALUPE
PERCOLATING DAM
SCALE: AS SHOWN
DATUM: U.S.C.S.
DATE: AUGUST, 1931.
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PLATE 17

of the other percolating dams. It will be a permanent concrete structure with radial spillway gates to permit the water to pass through unobstructed, when so muddy as to be unsuitable for percolation. The main conduit from the Coyote will discharge into the percolating reservoir at this point. Water will be backed up above the junction of the creeks about one-half mile, submerging about 45 acres at the flow line elevation of about 190. This will back up water discharged into the reservoir by the Coyote conduits up to the proposed Almaden pumping plant which will pump it through the pressure main connecting it with the West Side canals. The reservoir will, therefore, function as about ¾ mile length of the main marginal valley conduit. Tests have indicated an especially high percolating rate in this gravel area which it is estimated will sink water into the underground gravels at the rate of four acre feet per day or 2 sec. ft. per acre. It will, therefore, have a percolating capacity of 90 sec. ft. The ground water contours indicate that it is especially favorably located for the transfer of underground water northwesterly toward the large areas of severe depletion west of San Jose. This reservoir functioning as part of the main marginal valley conduit will normally be full from four to six months in each year and should give very satisfactory stream bed percolation into the Guadalupe area.

As explained in Chapter III, Table 7, the service of this reservoir is so greatly affected by the large surface storage reservoirs above that its cost and service will be grouped with the detention reservoirs instead of the percolation reservoirs. It will be included for convenience of comparison only, in Table 10.

Los Gatos Creek—Percolating Reservoirs.

The Los Gatos creek is one of the most valuable watersheds tributary to Santa Clara Valley. The watershed area is about 10% of the total tributary to the Valley and the run-off is about 21%. It is most unfortunate that the only good foothill reservoir site is at Lexington and is occupied by the Southern Pacific R. R. and the highway. The cost of moving the railroad and highway would be prohibitive. There are no other known reservoir sites of sufficient capacity to control the stream. Between Los Gatos and Campbell, however, the stream passes over large areas of porous gravel where by surface erosion it has greatly enlarged its width. It thus presents exceptionally good opportunities for the development of percolating stream bed reservoirs. In the aggregate these will have sufficient storage to effect satisfactory regulation of short sudden floods, holding them back until they can be absorbed. Three substantial structures are proposed between Los Gatos and Campbell. These will be so located as to take advantage of topographies which will enable the maximum area of stream bed to be covered at the minimum cost for dams. All three dams will be provided with movable superstructures so as to permit the unobstructed passage of flood water when such water is too muddy to be suitable for percolation. Long sustained floods of magnitude can be allowed to pass unobstructed down the stream bed in order to flush out the percolating areas. The three dams will be located just above Vasona Junction, just above the electric railroad crossing near the old Page dam, and just above the Campbell Ave. bridge. The total storage capacity of the three percolating reservoirs to be formed, will be about 900 acre ft., about ¾ of which will be in the upper reservoir. The upper reservoir will thus

be sufficiently large so that during moderate rates of flood flow it can desilt the river, furnishing clear water to the important percolating areas created by the lower dams. The central dam may be so located that it will also function as a diversion dam for the old Page ditch now owned by the District and for about 5 acres of supplementary percolating areas adjacent to the creek bed, which it is proposed to purchase for this purpose. This arrangement will have the additional advantage of allowing the transfer of Los Gatos creek water, desilted by the upper reservoir, through the District's Page ditch and to the San Tomas creek, the best percolating stream bed of all.

Vasona Dam:

This dam will be located at the sharp bluff where the railroad enters the canyon and will be a standard earth dam about 1,000 ft. long with a maximum height of about 30 ft., built of gravel and earth. A concrete spillway with special radial gates 15 ft. in height and 20 ft. long with a capacity of 10,000 sec. ft. will be provided at the right abutment of the dam. This spillway will discharge 15,000 sec. ft. before the dam is overtopped.

Page Dam:

The central dam will be located near the headworks of the old Page ditch and will consist of a gravel and earth levee across the creek bed about 15 ft. in height. At the present main stream channel, a concrete structure will be provided so as to permit the unobstructed passage of flood water up to 10,000 sec. ft. Detailed surveys for this structure are not available but it is estimated that the structure will have a total length of about 1,000 ft. and a maximum height of about 15 ft. and submerge about 20 acres. Estimates provide for new headgates for the release of water under control into the old Page ditch. Estimates also provide for the acquisition of five acres of additional gravel bed adjacent to the creek for supplementary percolating areas. These areas are apparently of exceptionally open porous formation for this purpose.

Campbell Avenue Dam.

At the Campbell Avenue bridge is a sharp "bottle-neck" in the Los Gatos creek bed. The creek cross-section is much narrower beneath and below the bridge than above the bridge. This, topographically is a very good location for a dam. It is proposed at this point to construct a permanent dam of concrete with radial gate superstructure with permanent sills at the approximate creek bed elevation of 175, and with a top which will be the same as the maximum water surface at elevation 190. This will bring the water at maximum height nearly up to ground level, the bridge floor elevation being 196. The area submerged will be about 25 acres. 54 acres, or two and a half times as great an area could be submerged by raising the water height to elevation 200. This elevation, which was formerly proposed, might, however, create objectionable seepage conditions in adjacent property in the town of Campbell. It will be noted that the present proposal is to construct two dams, one at Campbell Avenue and one at the old Page ditch, each about 15 ft. high, in place of the one formerly proposed at the Campbell Avenue bridge, 25 ft. high.

The total area submerged by the three dams will be about 110 acres. Additional stream bed percolation induced should certainly be in excess

of 100 sec. ft. It is believed that the central area in particular will have a much higher normal rate of stream bed percolation than 2 ac. ft. per day or 1.0 sec. ft. per acre. These three structures will at least double the normal maximum stream bed percolation rate of the Los Gatos creek.

Los Gatos Spreading Dams.

It is proposed to supplement the three percolating reservoirs on the Los Gatos by the construction of an additional 2,000 ft. in the aggregate, of 2 ft. "sausage" spreading dams. If the creek bed in this location has a fall of about 1 ft. in 200 or about 25 ft. per mile, then 2 ft. "sausage" dam will back the water up an average distance of 400 ft. and 100 ft. of such dam would submerge about one acre at a possible construction cost of about $500 per acre in addition to the cost of end protection for each structure. 2,000 ft. of such "sausage" dams will then submerge an additional 20 acres at a probable cost of about $12,000.

TABLE 11
LOS GATOS CREEK IMPROVEMENTS

STRUCTURE	Acres	Capacity Ac. Ft.	Absorption Sec. Ft.	Est. Cost
Vasona Percolating Reservoir	65	650	65	$163,000
Page Percolating Reservoir	25	150	25	63,000
Campbell Percolating Reservoir	25	150	25	29,000
"Sausage" Dams	20	20	20	12,000
TOTALS	135	970	135	$267,000

TOTAL aggregate percolating capacity 135 sec. ft., cost $1610 per sec. ft. capacity.

In addition to the increased stream bed percolation, both the Page ditch and the new District conduit should each be capable of diverting from the Los Gatos creek about 150 sec. ft. for transfer to the San Tomas creek and other percolating areas to the west. Stream flow on the Los Gatos creek could thus be used up to a minimum rate of about 500 sec. ft. It has been estimated that the normal run-off of the Los Gatos is about 42,000 acre ft. of which about 15,000 is naturally absorbed or 35%; 27,000 acre ft. is normally wasted. The project proposed would apparently for this most important stream, increase the maximum rate of utilization from perhaps 200 sec. ft. to 500 sec. ft. It might be estimated that these additional works would enable the salvage of at least one-third of the present average waste, or say about 9,000 acre ft. per annum from the Los Gatos.

WEST SIDE STREAMS:

San Tomas Aquinas, Campbell, Calabazas and Permanente:

The four west side streams listed above on which surface storage is not proposed, will all be given similar treatment, designed to artificially increase their natural stream bed percolation. The West Side Canal crosses each of these streams close to the western margin of the District. Reservoir water can be released from this conduit into each of the stream beds. The ground water contours shown on the State Water Resources map indicate the most receptive areas for stream bed percolation in each of these streams to be at or a short distance above, the canal line crossings. Stream bed percolating works should, therefore, be generally concentrated in the vicinity of the canal crossings. The average fall in the stream beds is about 50 ft. per mile or one foot per 100. A "sausage" dam 2 ft. high will back the water up about 200 ft. and it would take about 200 lineal feet of

such dams to submerge an acre. Similarly with percolating dams 5 ft. high, about 80 lineal ft. would be required to submerge an acre. Wherever the stream beds tend to be wide and shallow and there is a sufficient supply of gravel or cobbles, the "sausage" type spreading dam is cheapest. There is a considerable portion of the stream bed of Campbell creek from Saratoga to Cox Avenue, capable of this method of treatment. Portions of the Calabazas and San Tomas can also be treated this way and there may be opportunity for one or two structures of this type on Stevens Creek, between the Fremont and Homestead roads.

A permanent structure will be required at Stevens Creek where the West Side conduit crosses the creek at the boundary line of the district and the railroad. A concrete sill with movable superstructure will be provided and will back the water a considerable distance up Stevens Creek and will also act as a diversion dam to divert Stevens Creek reservoir releases into the small canal intended to transfer water for percolation from the bed of Permanente Creek. Particularly favorable percolating areas apparently exist in Campbell Creek (See Figure 9), between Saratoga and Cox Avenue and these should be developed even though they are above the main West Side canal. The three smaller streams, San Tomas, Calabazas and Permanente Creeks, have rather uniform cross-sections and as none of them have heavy flood flows, it is believed that stream bed percolation can be augmented by small concrete structures with permanent crests, of the type the district has already been building on the Los Gatos and Stevens Creeks. The natural absorption rates on the San Tomas and Calabazas appear to be so high that not much further treatment is necessary. The Permanente Creek bed is smaller and less pervious and hence will require more treatment. For this reason also, the Permanente has been recommended for the most complete mountain check dam control of all.

There are now permanent diversion dams built for winter irrigation in the Los Gatos, Campbell, (Figure 10), and Stevens Creeks, which should be used for additional stream bed percolation either as they are or as they will be repaired.

The following Tables 12 and 13 indicate the tentative distribution of structures proposed for stream bed improvement. Final location and designs will undoubtedly change many of these structures. A portion only, should be built during the first season and the effect of these accurately determined as a guide to the final location and modification of the remaining structures.

TABLE 12
SPREADING DAMS

STREAMS	Max. Nat. Abs. Rate Sec. Ft.	Spreading Dams		Spreading Reservoirs			Costs	
		Number	Length	Pond Area Ac.	Abs. Rate Sec. Ft.	Abs. Inc. Sec. Ft.	Total	Per Sec. Ft. Abs. Inc.
Penitencia	5	5	400	1.0	3.	3.0	$ 2,400	$ 800
Coyote	(80)	....	.....	....	....	....	.....	.....
Los Gatos	35	10	2,000	20.0	1.	20.0	14,400	720
San Tomas	36	5	200	1.0	3.	3.0	1,200	400
Campbell	58	20	2,000	10.0	2.	20.0	14,400	720
Calabazas	25	5	200	1.0	2.	2.0	1,200	600
Stevens	(39)	2	160	.8	1.	.8	1,152	1,440
Permanente	8	5	150	.7	1.	.7	900	1,287
....								
TOTAL	167	52	5,110	34.5	13.	49.5	$35,652	$ 720

TABLE 13

PERCOLATING RESERVOIRS

STREAM	Max. Nat. Abs. Rate Sec. Ft.	Percolating Dams Number	Size	Percolating Reservoirs Pond Area ac.	Abs. Rate sec. ft.	Total abs.	Total	Per Sec. Ft. Abs. Inc.
Penitencia	5	(5 ac. Gravel Percolating Area)		.....	2.00	(10.00)	$(6,000)	.....
		(Old Well and Tunnels)		.....	3.00	(3.00)	(1,200)	.....
				.....	.....	13.00	7,200	$ 554
Guadalupe (*)	(35)	(1)	10'high x 250'	(45)	2.00	(90.00)	(66,000)	733
		(Vasona	30'x1000'	65	1.00	(65.00)	(163,000)	2,510
Los Gatos (**)	35	(Page	15'x1000'	20	1.00	(20.00)	(63,000)	3,150
		(Campbell	15'x150'	25	1.00	(25.00)	(29,000)	1,160
				110		110.00	255,000	2,332
San Tomas	36	2	2½'x20'	0.3	3.00	10.00	1,200	400
Campbell	58	10	5'x40'	5.00	2.00	10.00	24,000	2,400
Calabazas	25	2	5'x30'	.7	2.00	1.4	3,600	2,570
Stevens (***)	(39)	1	10'x50'	.6	1	1.2	9,600	8,000
Permanente	8	10	5'x25'	3.00	1	3.00	14,400	4,800
	167	28		119.6		148.6	$315,000	2,620

(*) Guadalupe Percolating Dam is grouped with Detention Dams and hence excluded from the totals of this table.

(**) Los Gatos Percolating Reservoirs also give about 1,000 ac. ft. of storage or Detention Reservoir regulation.

(***) Stevens Creek Percolating Reservoir also functions as Diversion Dam for Reservoir release and assists Reservoirs in salvaging detained flood waters.

CHAPTER VI

COST ESTIMATES

COMPARATIVE PRICES

The entire cost of the present project has been very carefully re-estimated. The location of all proposed works has been studied in detail by the writer on the ground. Unit costs are very materially lower than those of ten years ago when the Tibbetts and Kieffer report was written. This is particularly true of earth work and concrete ditch lining. Greater safety provisions, however, are enforced by the State authorities in the construction of dams and reservoirs, hence, the spillways of the present project are more liberally designed and more expensive than those of ten years ago.

To the writer's best estimate of the contract prices of various portions of the project, there has been made a flat addition to each item of 20% to cover incidentals, contingencies, administration, legal and engineering expenses. The total cost of the project herein recommended is five and one-half million dollars or almost exactly half as much as the project of ten years ago.

UNIT PRICES

Earth Fill in Dams	$ .35 to .40 per cu. yd.
Core Trench Excavation	1.00 per cu. yd.
Asphalt or Concrete Slope Paving	.25 per sq. ft.
Outlet Tunnel, lined	25.00 per ft.
Spillway Excavation	1.25 per cu. yd.
Spillway Lining	.42 to .50 per sq. ft.
Flexible Concrete Block Mattress	.75 per sq. ft.
Reinforced Concrete at Dams	25.00 per cu. yd.
Reinforced Concrete in small structures, including excavation	50.00 per cu. yd.
Canal Excavation, including spreading and spoil	.20 per cu. yd.
Gunite Canal Lining, Reinforced	.10 per sq. ft.
Pipe Lines, Flumes, Pumping Machinery, Valves, Etc.	Manufacturer's Quotations
Canal Rights of Way (Average)	$1,000 per acre
Road Re-location	$5,000 to $7,000 per mile

Reservoir Lands and Improvements—Recent Appraisals by Chief Engineer.

DETENTION RESERVOIRS

ESTIMATED COST

Reservoir	Dam	Outlet	Spillway	Land and Improvements	Total
Coyote	$ 845,900	$103,700	$ 774,800	$240,000	$1,964,400
Calero	238,300	32,300	38,900	60,000	(369,500)
Almaden	112,500	33,700	44,200	23,400	(213,800)
Calero Canal and Tunnel	.....	.....	.....	.....	(226,000)
Calero-Almaden System	.....	.....	.....	.....	809,300
Guadalupe	188,100	37,400	78,900	19,200	318,600
Stevens	235,600	47,300	80,800	85,200	448,900
Guadalupe Percolating	58,500	.....	.....	6,500	66,000
TOTALS	$1,678,900	$254,400	$1,012,600	$434,300	$3,607,200

DISTRIBUTION SYSTEM

Item	Estimated Cost	
Narrows Canal	$ 34,700	
Edenvale Siphon	59,400	
Edenvale Canal	9,000	
Edenvale Pumping Plant	31,800	
Edenvale Pressure Pipe	57,800	
Almaden Pumping Plant	70,600	
Almaden Pressure Pipe	132,700	
Guadalupe Canal	124,700	
West Side Canal		
To Campbell Creek	74,000	
Campbell Creek to Calabazas Creek	21,600	
Calabazas Creek to Stevens Creek	45,800	
Stevens Creek to Permanente Creek	18,200	
SUB-TOTAL—WEST SIDE SYSTEM		$680,300
East Side Canal to Pumping Plant	117,900	
East Side Pumping Plant	21,000	
East Side Pressure Pipe	23,600	
East Side Canal, P_3 P_4 to Penitencia Creek	19,100	
SUB-TOTAL—EAST SIDE SYSTEM		181,600
Narrows Diversion Dam		93,600
Almaden Supply Canal		71,000
GRAND TOTAL		$1,026,500

POWER DEVELOPMENT

Item	Estimated Cost
Power Canal	$121,200
Penstock	16,700
Power Plant	180,700
Power Line	51,848
TOTAL	$370,448

COST ESTIMATES

RECAPITULATION

Detention Reservoirs	$3,607,200
Distribution System	1,026,500
Power Development	370,448
Watershed and Stream Bed Improvements	495,852
GRAND TOTAL	$5,500,000

SANTA CLARA VALLEY WATER CONSERVATION DISTRICT

SUMMARY

OF A

REVIEW OF THE
REPORT ON WASTE WATER SALVAGE PROJECT
MADE SEPT. 1, 1931, TO BOARD OF DIRECTORS

BY ITS

CHIEF ENGINEER, F. H. TIBBETTS, MEM. AM. SOC. C. E.

ALSO

ESTIMATES OF PRESENT AND PROBABLE FUTURE
EXTENT OF WATER SHORTAGE, EFFECT OF
PROPOSED WORKS THEREON, AND
ESTIMATES OF THEIR COST

BY

H. L. HAEHL, Mem. Am. Soc. C. E.
SAN FRANCISCO, CALIFORNIA

October 1, 1931

H. L. HAEHL
MEM. AM. SOC. C. E., MEM. AM. SOC. M. E.
IRRIGATION, RECLAMATION, WATER SUPPLY
1314-18 HUMBOLDT BANK BLDG.
SAN FRANCISCO, CAL.

October 1, 1931.

Board of Directors,
Santa Clara Valley Water Conservation Dist.,
Auzerais Building,
San Jose, California.

Gentlemen:

On September 5, 1931, you requested that I review the report of your Chief Engineer, Mr. Fred H. Tibbetts, Mem. Am. Soc. C. E., made to you under date of Sept. 1, 1931, and entitled "Waste Water Salvage Project" in which a plan for the conservation of your water supply is outlined.

You asked that after such review and at the earliest possible date, I advise you as to the present water-shortage in your District, as to its probable future extent in case no remedial measures are taken, as to the feasibility, desirability, and cost of the works for salvage of water proposed in Mr. Tibbetts' report, and the effect thereof upon the available supply.

Since the above request was received, I have been continuously engaged on the work, have visited the sites of all of the proposed works, and caused a geological study to be made by Mr. Hyde Forbes, Consulting Geologist, covering the suitability and safety of sites and character of available materials for the construction of dams and other works as planned. I have also examined the Report and the engineering data collected in its preparation by Mr. Tibbetts, assembled and analyzed additional data from various sources, including streamflow and ground-water records secured by me during a 29-year period, and have carefully checked the preliminary designs, estimates of quantities, and the probable cost of the works proposed. Owing to your need for an early conclusion, this report is in the nature only of a summary of the facts found and conclusions reached.

Present Ground Water Shortage.

The source and nature of the supply of ground-water beneath the District is well described in Mr. Tibbetts' Report and in other previous reports*. Substantially all the supply is absorbed into the gravels and sands comprising the bed and banks of tributary streams near the apexes of their several detrital cones. This conclusion is not a matter of unsupported theory; it has been definitely determined from years of measurements of the stream-losses and the coincident filling of the ground-water storage,—reflected by rising levels in wells progressively outward from the source of replenishment to and beneath the District.

*Report to Santa Clara Valley Water Conservation Committee, March 1921, by F. H. Tibbetts and Stephen E. Kieffer.
Ground Water in Santa Clara Valley, California, (1924) U. S. Geological Survey, W. S. Paper No. 519.
Progress Report on Santa Clara Investigation (1930), State Division of Water Resources, E. N. Bryan, Hyd. Engr.

A record of measurements for substantially 29 years upon the Coyote River (which alone provides nearly 40% of the surface streamflow entering the District and about 30% of the ground-water replenishment) together with less continuous records on the other major streams demonstrating the similarity in conditions, affords a substantial basis for an analysis of the present supply and the intelligent outlining of measures for improvement.

Substantially all of the flow at ordinary rates of discharge on the tributary streams (as distinguished from flood rates) passes underground each year. Floods, however, pass so rapidly and constitute such a large proportion of the total annual stream-flow that, for example, during the 29 years of record (1902-1931) approximately two-thirds of the Coyote flow entering the Valley passed over its bed and was lost in the Bay. Of all the stream-flow entering the Valley, it is estimated that 62% is normally thus wasted.

The amounts absorbed and wasted vary widely from year to year. Replenishment to ground-water beneath your District over a cycle of years with average rainfall equal to the normal is probably about 75,000 acre feet per annum. Prior to artificial draft on this supply through pumps, the ground-water levels fluctuated from month to month with the differences in rates of replenishment but varied only slightly from year to year.

Since pumping in your District reached substantial proportions there has been a progressive decline in water levels. The data as to (1) comparative rates of replenishment (as reflected by the Coyote measurements), (2) power used in pumping, and (3) decline in ground-water levels, are shown graphically on the Diagram next following.

It will be apparent at once from inspection of this diagram that with the rapid growth of pumping the depths to ground-water under your District, (which had reached an average of 110 feet in the spring of 1931) must continue to increase unless very positive remedial measures are taken. Years of plentiful stream-flow, even during the periods with less than the present amounts of pumping for irrigation, have effected only slight and temporary check on the downward trend. Average years no longer maintain ground-water levels.

I have subjected all the data available, including that on which this diagram is based, to careful analysis, with the following conclusions:

(1) During the 16-year period from 1915 to 1931 with average rainfall about 85% of normal; ground-water replenishment approximately 75% of normal; and the estimated average annual extraction about 70% of the present draft, the water levels under your District fell an average of 4.8 feet per year—a total of 76.5 feet.

(2) The gradual increase in agricultural pumping draft during this period was such that since 1927 it has exceeded the normal annual replenishment to be expected from natural sources. If the additional, but less determinable, draft for domestic use and some unavoidable outflow to adjacent territory is included, it is probable that the total ground-water draft had exceeded normal supply as early as 1921.

Probable Future Shortages.

Unless controlled by artificial means, future ground-water levels in the District will depend upon (1) the annually changing rainfall, runoff, and replenishment; and (2) the growth in pumping draft.

Natural Replenishment over a cycle of years giving normal rainfall averages about 75,000 acre feet per annum.

Pumping Draft, for irrigation only, now approximates 100,000 acre feet per annum. The area under irrigation in your District was estimated at 95,000 acres in 1930. It is estimated that an average of 120,000 acre feet per annum may be required for the irrigation service of your District in the future if present character of crops is not changed.

These considerations indicate the necessity for an addition to the average natural replenishment of about 45,000 acre feet per annum to meet average ultimate irrigation requirements and about 25,000 acre feet to meet immediate future requirements in your District without allowances for domestic uses, some unavoidable draft from marginal areas, and the recent marked tendency toward increased acreage in truck-crops and berries requiring greater applications of water.

Assuming that following 1931, there will occur a cycle of years the average of whose rainfalls will equal the normal, and assuming no provisions made for increasing natural replenishment, it appears from the data now available that an average drop in water-levels at an initial rate of about 3 to 4 feet per annum and an ultimate rate of 7 or 8 feet per annum will be inevitable and that any included years of large flood flow may cause temporary but only partial recoveries.

Suitability of Proposed District Plan.

The waste-water salvage plan proposed by your Chief Engineer contemplates an average annual addition to ground-water of approximately 60,000 acre feet, by the temporary detention of excess flood waters in reservoirs of limited capacity; their release to the upper pervious reaches of stream-beds at rates which permit of complete absorption; spreading and percolating works on the natural channels; check dams on watersheds incapable of storage-treatment; and a system for the distribution of salvaged water to areas of deficiency.

After careful study I find this plan to be sound and well conceived from an engineering standpoint. While the works designed for spreading and percolation involve no new or untried principles, their successful planning will, nevertheless, require extensive tests and measurements to determine the proper location and type of works. These will involve time and expenditure. I have suggested some additions to cost estimates to safely cover this feature.

The strength of the proposed plan lies particularly in the conveyance of the waters to the upper pervious portions of the several streambeds from which absorption is most certain and rapid and from which the certainty of underground distribution to the lower District areas is assured by the knowledge that natural absorption and distribution follows these channels.

The plan includes also ingenious provisions for generation of power from reservoir releases on the Coyote River to lift a part of the excess supply to required heights on the west side of the Valley,—the water for power generation and exportation being automatically unavailable during any season until there has first been stored the amounts necessary for replenishment of the lands naturally supplied from that stream.

I estimate from study of the data now available that under the proposed plan recovery of the present depressed water table may be secured during a cycle of years of normal rainfall at a rate averaging about 3 feet per annum until an ultimate irrigation draft of about 120,000 acre feet per annum is reached. With the uncertainties in estimates of future needs and particularly of changes in draft which may then occur, due to domestic and industrial uses and unavoidable outflow to adjacent territory, it is not possible from present information to safely conclude that recovery may be expected to continue after ultimate irrigation requirements are reached and supplied, without some further salvage of waste waters. It is probable, however, that the average water levels then secured can thereafter be maintained with the amount of replenishment provided under the present plan. In event of unusual industrial growth or changes in irrigation requirements, such that further salvage then becomes necessary, the possibility of extension of works still exists. The works now proposed, while in my judgment all that will be required at this time, cannot be safely either reduced or deferred.

Probable Cost of Proposed Works.

Geological examination of the sites for the proposed reservoirs has confirmed the suitability of the foundations for the proposed structures at the Coyote, Calero, Almaden and Guadalupe sites. The character of the foundations at the Stevens Creek dam site proposed in the plan is, however, questioned and the available materials for construction of earth-fill dams at the Almaden and Guadalupe are found insufficient. These two sites, however, are reported well-suited for rock-fill or masonry structures and good construction materials therefor are available.

Other sites for reservoirs are also available on Stevens Creek and on minor watersheds nearby, so located that they can be substituted for the regulation of Stevens Creek flow, if exploration of the foundations at the site originally proposed confirms the conclusions of the Geologist based on surface observations. It is also feasible to replace the supply planned from this source by increased salvage of Coyote waste waters, involving 15,000 acre feet of additional storage capacity at that reservoir and some increase in transportation canal capacity and period of pumping. Estimates of cost used herein are based on this latter alternative and upon the construction of masonry dams at the Almaden and Guadalupe sites. Alternative studies in final design may effect some improvements and savings in these and other features of the plan.

The addition of a by-pass canal has been suggested and is included on the Coyote River to increase the flexibility of operation in order that injurious flooding of low-lying lands may be definitely avoided. Due to the release of stored water over long periods the extent of replenishment in the Coyote area might otherwise produce dangerous high ground-water levels.

With these and some other suggested additions and changes in plans taken into account, I have carefully checked and recalculated the estimates of cost and find that based upon present (1931) cash construction costs, with suitable allowances for overhead costs including interest during a reasonable period for construction and for unusual expenses incident to

development undertaken in a well settled area, the works proposed in his Report as thus amended can be built for the sum of $6,100,000.

This cost includes provisions for elements concerning which some reasonable questions may arise, as follows:

Fencing canal rights-of-way	$ 84,000.00
Clearing of Reservoir lands (net)	25,000.00
Check dams—relatively impervious areas	61,000.00
Use of private rights-of-way for pipe line where use of roads may be permitted	5,000.00
Salvage on reservoir lands included outside of flow lines	15,000.00
Total	$190,000.00

Should your Board conclude that any of these costs can safely be omitted or deferred the required funds may be correspondingly reduced, the minimum provision being for $5,910,000.

Present costs of construction are about 77% of those applicable in March 1921 (when the former estimates of the Tibbetts-Kieffer Report were presented) and have declined approximately 12% during the nine months of 1931. A distinct financial advantage in present low construction costs and interest rates lies with the District if its project is promptly carried out.

The estimates herein given assume (as seems probable) that the present purchasing power of the dollar expended for the construction of works of this nature will continue during a construction period of approximately three years.

Economic Considerations.

After careful analysis of all available data, I am forced to the conclusion that the water supply obtainable by your District from the natural ground-water replenishment is sufficient to continuously and dependently supply somewhat less than 65% of the ultimate irrigation demand of your area. Within a short period 35% or more of your area must therefore be deprived of supply (and the costs of securing the remaining supply continue very great) unless measures equivalent to those proposed in your present District plan are carried out.

Unless, therefore, it will be found cheaper and more desirable to destroy approximately 35% of the values within the District than to expend approximately $6,000,000.00 to maintain them, the economic necessity for the proposed works of conservation must be conceded.

Unless works as now proposed are shortly constructed and placed in operation, such a further increase in average pumping lifts in your District will occur that the costs of pumping must shortly become prohibitive. This condition even now exists in parts of the District.

Since the beginning of the decline in water levels in about 1915 (see Diagram herewith) the following increases have taken place (to 1931) in the San Jose District*:

*The San Jose District referred to is the P. G. & E. Power Co. District which is nearly coterminus with the Conservation District.

Increase in depth to ground water.....76.5 ft.
Increase in Horse Power installed (pumping)....38,100 H.P. (368%)
Increase in Annual Power used (electric,—for pumping) .....45,840,000 KW-Hrs. (1550%)
Increase in Annual Power used per installed horse power .....724 KW-Hrs. (347%)
Increase in Annual Cost of Power per H. P. of installed pumping capacity at average rates collected in 1930.....$12.70 per annum.
Increased Annual Cost of Power for the 52,300 H. P. (approx.) of connected agricultural load in 1931, over cost for same installed H. P. in 1915 .....$665,000.00 per annum.

The amount of water annually pumped in the District has increased approximately 60% in the 10 years since the date of the Tibbetts-Kieffer investigation in 1921. The amount of power consumed in pumping 60% of additional water, however, has increased 268% owing to the increased lifts. Many millions of dollars* have been expended in your District since 1915, and very substantial sums since 1921, in deepening existing wells, and enlarging pumping equipment and much added cost has been involved in all new installations because of the lowered water-table. These capital costs, however, cannot now be recovered. The increased operating costs during these years greatly exceed the capital costs but are likewise not now recoverable.

If no relief is now afforded, the cost of securing water must still increase, due to further deeping of wells and enlargements of plants, to the point where net agricultural returns will no longer justify present land values except for those lands in favored locations adjoining the source of supply.

The amounts of water reservoired underground have been seriously reduced during these years of overdraft. If only ultimate annual irrigation requirements are provided by the works planned, no surplus will be available for the gradual return of this ground-water storage—and the incident recovery of ground-water levels—unless the works are completed and in operation safely before the time when ultimate draft is reached. If, therefore, the present proposed development is at all delayed, the extent and cost of works necessary to effect any recovery in water levels and diminution in present annual pumping costs, must be correspondingly increased.

All of these considerations lead me to conclude that the works proposed are not only necessary at this time, from an economic standpoint, but represent the minimum provisions for ground-water relief which can now be recommended.

*Data in this regard are incomplete and involve considerable estimate. After considering the data available, I am led to believe that the capital costs of deepened wells and pits, and increased pumping installations due to the water-table drop may have exceeded $6,000,000.

CONCLUSION.

With the foregoing preliminary explanations, I am able to reply specifically to the questions propounded by you, as follows:

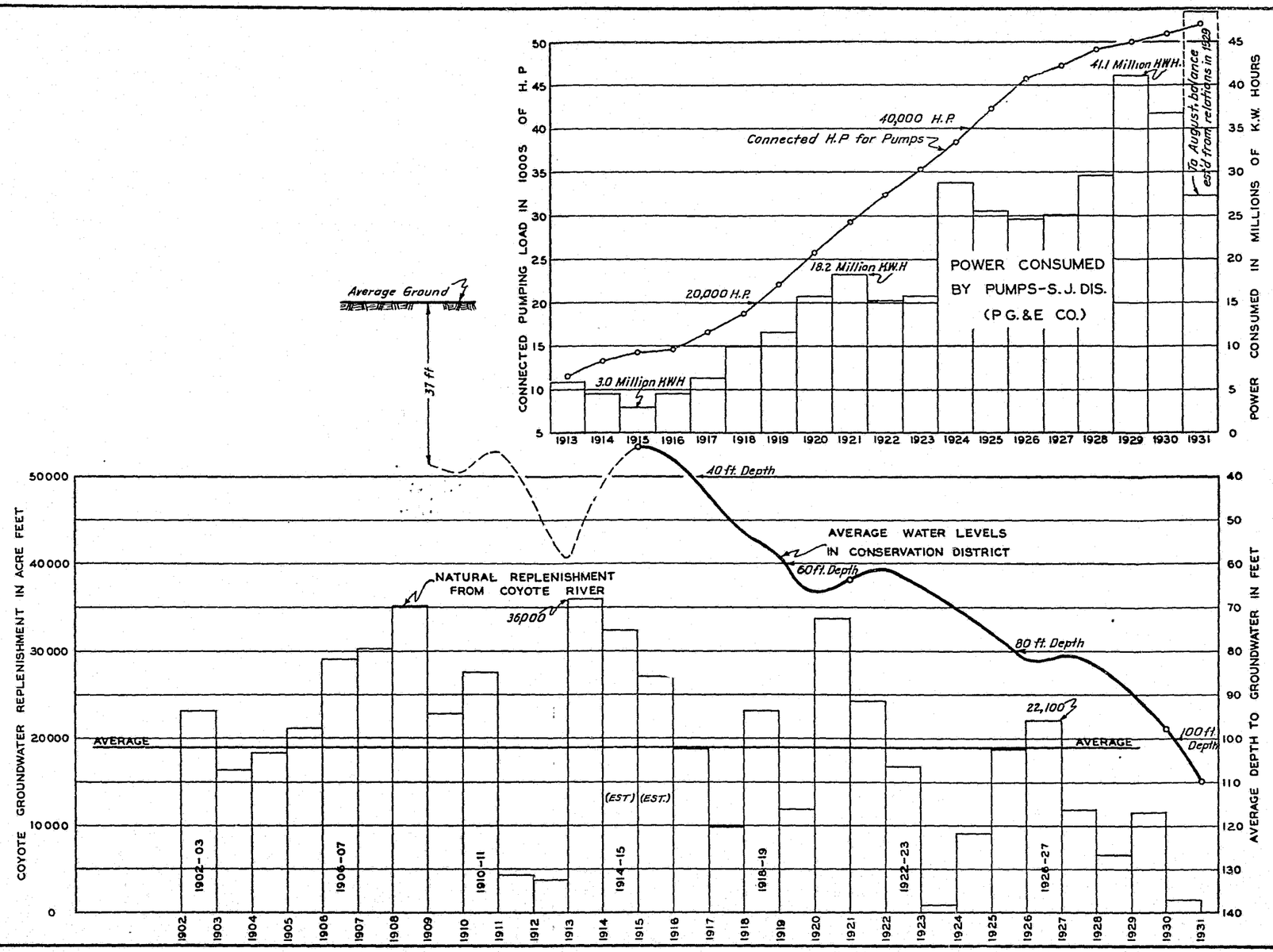
1. The present ground-water shortage in your District results from an annually increasing draft through wells which exceeded the normal replenishment in about 1921,—is now about 25,000 acre feet per annum in excess of such normal supply; and has brought about a water-table lowering of 76.5 feet (average) in the last 16 years. The incident increase in annual power consumption for pumping, per installed horse-power, is 347% and the pumping cost in the District in excess of that which would have been required had water-levels remained as of 1915, is now in excess of $500,000 per annum and probably approaching $1,000,000 per annum.
2. In case no remedial measures are taken to augment the natural replenishment of your ground-water supply, further decline in levels at rates varying with seasonal conditions, may be expected. I estimate that normal decline may be 3 to 4 feet per annum under present conditions of draft and that when the District is fully developed agriculturally will be 7 to 8 feet per annum. The supply available without artificial replenishment is estimated to average somewhat less than 65% of that which will then be required.
3. The works proposed by your Chief Engineer for the relief of your water shortage are well conceived, feasible of construction and operation, and should afford a dependable annual supply at least equal to the ultimate draft reasonably to be expected in your District. Their operation should effect some refilling of underground storage and recovery of water levels at a rate approximating 3 feet per year if promptly constructed and until ultimate irrigation draft is reached. If construction and operation is further delayed, the normal increase in demand will make it necessary to provide more extensive works than now proposed in order to overcome the increasing annual draft and at the same time effect any refilling of the ground-water reservoir or the resumption of higher pumping levels within any reasonable period of years.
4. I estimate the present cash cost of the works as now proposed to be $6,100,000.* They represent, in my judgment, the minimum provisions which can be recommended for the maintenance of your water-supply and of the present values in your District. Their cost is also justified by the savings over annual pump operating costs which otherwise are to be expected and I recommend that they be promptly built and operated.

In addition to the engineering data herein referred to, there was collected and considered in the preparation of my report, much valuable information gathered locally from numerous organizations and individuals. Acknowledgment thereof is only generally made in this summary. Specific acknowledgents will accompany the presentation of details which will later be afforded you.

Respectfully submitted,

H. L. HAEHL,
Mem. Am. Soc. C. E.

*or $5,910,000 with the possible eliminations discussed.



NOTES

Ground Water Replenishment shown is that measured (and in part estimated) for the Coyote River between Upper Gorge and the Narrows. No similar data are available on other Valley Streams except for the year 1930. The variations in Coyote replenishment are considered as characteristic of the variations from the Valley Streams as a whole

Power Consumption covers electric energy only. It is based on the records of the Pacific Gas and Electric Company for the San Jose District, (Palo Alto to Coyote) which includes and slightly exceeds the Conservation District area. For the years 1927 to 1931 it is derived from total sales in the San Jose Division, by application of percentages previously determined. Connected Pumping Load (in H.P.) is similarly secured from Pacific Gas and Electric Company Records

Depth to Average Ground Water for the Conservation District area is that determined by the Division of Water Resources (Progress Report of E.N. Bryan, Member Amer. Soc C.E.) for the spring months of 1915, 1921, 1930 and 1931 from observations on 246 wells, with interpolation based on a limited number of wells with continuous records.

SANTA CLARA VALLEY WATER CONSERVATION DISTRICT

DIAGRAMS SHOWING ANNUAL VARIATIONS

IN

GROUND-WATER REPLENISHMENT
POWER CONSUMED BY PUMPS
AND
DEPTHS TO GROUND WATER

1902 - 1931

TO ACCOMPANY REPORT OF H.L HAEHL, MEM. AM. SOC. C.E., 1931.

BOARD OF DIRECTORS

Santa Clara Valley Water Conservation District

Sidney D. Farrington	Division I
Leroy Anderson	Division II
R. P. Van Orden	Division III
J. Fred. Holthouse	Division IV
Ralph F. Simons	Division V
John A. Fair	Division VI
C. D. Cavalleiro	Division VII

MINUTES

March 19, 1936.

The Board of Directors of Santa Clara Valley Water Conservation District met in the office of the District, Room 62 Grant Building, San Jose, California, at 2:00 o'clock P.M. on the above date pursuant to adjournment taken on March 17th, 1936.

Present: Directors Farrington
Noethig
Van Orden
Holthouse
Mitchell
Parry
Pfeifle.

Absent: None.

There were also present Secretary Leroy Anderson, Attorneys Herbert C. Jones and Lloyd A. Mason and Mr. Geo. C. Holberton.

The hour of 2:00 o'clock P.M. having been advertised as the time for opening the bids for buildings on the former Brason property in the Stevens Creek Reservoir site, the Secretary opened the bids. There were nine bids in all and the high bids were as follows:

Item No. 1, Sunset Wrecking Company	$137.50	
Item No. 2, William C. Brown	18.00	
Item No. 3, Sunset Wrecking Company	15.00	
Item No. 4, Santa Clara County Council of Boy Scouts	11.00	
Item No. 5, Tony Gomes	15.00	
Item No. 6, M. E. Marciel	32.50	
Item No. 8, O. J. Clewett	7.50	
Item No. 9, Tony Gomes	15.00	
Item No.10, Tony Gomes	8.00	
Item No.11, O. J. Clewett	2.50	$262.00

On Item No. 7 there were three bids of $10.00 and one bid of $2.50. Upon motion by Director Parry, seconded by Director Van Orden and unanimously carried, all bids on Item No. 7 were rejected and the building which was a soft drink stand was presented to the Santa Clara County Council of Boy Scouts.

Attorney Jones reported on the proposed bond election and suggested a change in the date from the one tentatively set as April 21st. The City of San Jose has an election on May 5th and the Presidential Primary is on May 4th. The printed election indices are

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prepared for all precincts for these elections, but will not be ready for any earlier election. Hence, if the District held a bond election on April 21st, it would have to prepare its own indices, which would require such a large amount of extra labor at the County Clerk's Office that the expense to the District might exceed $500. If the District waits until after the City Election on May 5th this extra cost will not be incurred.

The financial statement to accompany the Engineer's Report was a subject of considerable discussion. In the absence of the Chief Engineer, no final decision was arrived at.

The Secretary read a letter from Mr. V. J. Whitehill, residing on the Los Gatos Creek, in which he stated that he would hold the District responsible for damage to his pumping plants and land flooded by the Vasona Reservoir.

President Farrington told of the need of care to the prune orchard on the Newman property purchased last season by the District. The orchard consists of approximately 30 acres. The Secretary was authorized to take up the matter with Mr. W. L. Atkinson, a member of the Right-of-Way Committee, to see if a satisfactory lease could be negotiated at as early a date as possible.

The Secretary read a letter from the Los Gatos Chamber of Commerce in which it requested permission to plant a small triangle of land owned by the District situated near Vasona Junction. Their desire is to make the approaches to Los Gatos as beautiful as possible. Upon motion by Director Mitchell, seconded by Director Noethig and unanimously carried, the Secretary was directed to notify them of the Directors' approval of the request.

The Secretary reported a call from Mr. A. N. Losse who has a diversion ditch on the Stevens Creek near Fremont Road. Mr. Losse particularly asked if the reservoir could not be closed at night and opened during the day, thus releasing 24 hours of stream flow during the period of 12 hours since most land owners did not like to irrigate

at night. This would give a better stream flow to all who have a right to take it. Attorney Jones stated that it would not be legal to interfere with the regular flow of the stream, and it should flow the same as all other streams.

Attorney Jones presented the following resolution inflicting $8,800 liquidated damages upon Bohnett and McDonald for 88 days' delay in completing Contract No. 2 after the contract date of December 1st, 1935:

RESOLUTION NO. 147.

WHEREAS, the contract for the construction of Almaden Dam and Spillway, Almaden-Calero Conduit and Calero Dams and Spillway, P.W.A. Docket No. 6051-2, provides that the time limit for the completion of said work is December 1st, 1935, and should said work not be completed or not be completed to the satisfaction of the District at said time, there will be deducted from the final payment under said contract the sum of $100.00 as liquidated damages and not as a penalty for each day's delay after the expiration of such period until the final acceptance of the work by said District and its delivery to said District, and,

WHEREAS, said work was not completed until February 27th, 1936;

THEREFORE, BE IT RESOLVED, that there be deducted from all moneys due or that may hereafter become due in accordance with the terms and conditions of said contract the sum of $8,800.00 as liquidated damages and not as a penalty for not completing said work on December 1st, 1935, in accordance with the terms and conditions of said contract.

The above resolution was adopted upon motion by Director Noethig, seconded by Director Holthouse, upon the following roll call:

Ayes: Directors Farrington, Noethig, Van Orden, Holthouse, Mitchell, Parry and Pfeifle.

Noes: None.

Absent: None.

The Board adjourned at 4:00 o'clock P.M. to meet Thursday, April 2nd, 1936, at 10:00 o'clock A.M.

Leroy Anderson
Secretary.

Approved: April 7, 1936.

Leroy Anderson
Secretary.

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